Solid Waste Management in Vientiane, Lao PDR

by

Vongvilay Khotpathoum

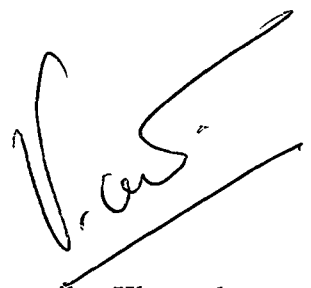
(University of Tasmania)

A thesis submitted in partial fulfilment of the requirements for a Master Degree at the School of Geography and Environmental Studies, University of Tasmania (October, 2008).

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any tertiary institution, and to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Signed



Vongvilay Khotpathoum

17th October, 2008

Abstract

The substantial growth in research into solid waste management in developed countries is well documented. However, the management and practices of solid waste in developing countries are not so well-known. Therefore, the purpose of this study is to focus on solid waste management in Vientiane Municipality, in Lao PDR, a developing country, and to learn from the experience of managing solid waste in Australia, a developed country.

Firstly, this thesis examines the general issues and solid waste management strategies in Australia, followed by Australian policy and legislative frameworks for solid waste management. Secondly, the study investigates the current issues, legislation and solid waste management practices in Vientiane, Lao PDR. A survey of solid waste management in Vientiane Municipality focuses on the Vientiane Urban Development Administrative Agency (VUDAA), two private waste contractors, and householders. The research methodology consisted of two survey questionnaires. The first was administered to the VUDAA and two private sector providers, and the other to 102 households in both urban and rural areas.

The survey results show that solid waste management practices in Laos are still inadequate, with poorly serviced households, inappropriate landfill management, weak financial status, and low community awareness. I argue that solid waste managers and households in Laos can learn from Australian waste management practices in order to improve their solid waste management practices.

Acknowledgments

I would like to thank the people whose support and contribution made this thesis possible.

Firstly, I would like to acknowledge the support received from my family. Words cannot describe the emotional feeling that I extend to my parents, sister, brother, and cousins for their support and belief in me during the pursuit of my educational goals. I also would like to acknowledge Mr. Teo Hwe Teq, a person who has given me valuable input and encouragement all the way through.

I offer my grateful appreciation is to Mrs. Margaret Eldridge who has helped me and welcomed me to share her home. I would not have had the opportunity to be here without her generous support. I particularly want to thank her for helping with English language.

Much appreciation extends to my supervisor, Julie Davidson, for her knowledge, ideas, thoughtful suggestions, patience, guidance, and time. She was always there when I needed help. This thesis would not have been completed without her.

Special thanks go to people in Vientiane, Laos. Especially, I thank those at Earth Systems Laos (the environmental consultancy company) - Mr. Viengvilay Duangphachan, Mr. Kongmeng Ly, and Mr Vixiene Kamphilavong. Also, thanks to Mrs. Nitkeo Khammy who brought the completed questionnaires from Vientiane.

Acronyms

ADB	Asian Development Bank
ATSDR	Agency for Toxic Substances and Disease Registry
DCTPC	Department of Communications, Transport, Posts and Construction
DOE	Department of Environment
EPA	Environmental Protection Act
EPR	Extended Producer Responsibility
ESL	Earth Systems Lao
GDP	Gross Domestic Product
GNP	Gross National Product
GTZ	Gesellschaft für Technische Zusammenarbeit
JFPR	Japan Fund for Poverty Reduction
JICA	Japan International Cooperation Agency
Lao PDR	Lao People's Democratic Republic
LDC	Least Developed Countries
MCTPC	Ministry of Communications, Transports, Post, and Construction
MTR	Mid Term Review
NCEE	National Centre for Environmental Economics
NGO	Non-Government Organisation
NKRS	National Kerbside Recycling Strategy
NMOC	Non-Methane Organic Compound
NSC	National Statistics Centre
NSW	New South Wales

NUOL	National University of Laos
NWMRS	National Waste Minimisation and Recycling Strategy
OECD	Organisation for Economic Cooperation and Development
PADETC	Participatory Development Training Centre
PPPUE	Public Private Partnerships for the Urban Environment
STENO	Science and Technology and Environment Organization
STEO	Science Technology and Environment Office
SWM	Solid Waste Management
UCS	Urban Cleansing Service
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
VUDAA	Vientiane Urban Development Administrative Agency
WHO	World Health Organisation
WMC	Waste Pickers' Multipurpose Centre

Table of Contents

List of Figures

List of Tables

Chapter 1: Introduction

1.1 Introduction

In recent decades, the rapid growth of cities in the developing world has resulted in increased consumption of resources to meet the rising demands of urban populations and industry, and this situation directly increases the amount of waste generation in cities (Boadi & Kuitunen, 2005). The growth of waste volume and the change in waste composition are attributed to a number of factors, such as rapid growth of population and economy (more people to produce waste and more money to buy products which will become waste in the end); insufficient infrastructure to deal with the growth; limited funding for planning and proper operation; lack of legal framework and political will for implementation and enforcement; lack of community involvement and clearly inadequate knowledge and skills to deal with or prevent such problems (Yousif & Scott, 2007). The outcomes of these changes and inadequate waste management practices are a direct impact on public health and the natural environment, allowing for the increase of uncontrolled dumpsites and refuse in the urban environment (Yousif & Scott, 2007). Thus, these factors are the axis around which poor waste management practices revolve.

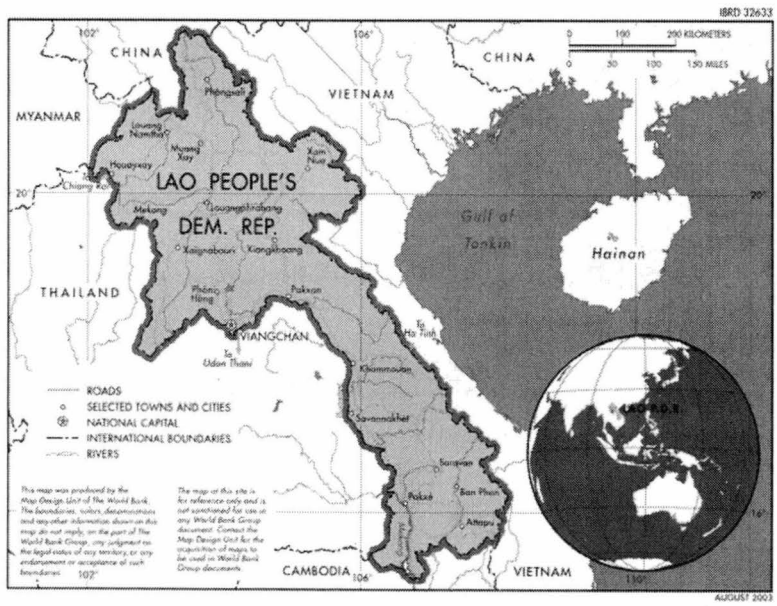
In essence, our quality of life is in direct relation to the way we manage our wastes. In order to achieve sustainable living, waste minimisation and management is fundamental for the well being of both the population and the environment. Because of weak institutional capacities and a lack of financial resources, both human and capital, solid waste management in many Third World cities (Boadi & Kuitunen, 2005), particularly in Laos, is in a deplorable state. On the other hand, in developed countries, such as Australia, institutional capacities and financial resources are not the major concerns; the main concern in developed countries is that rapid growth of population, coupled with strong economic conditions, has spurred solid waste generation much more than anticipated (Qian & Burritt, 2007). This study focuses on solid waste management in Third World countries such as Lao PDR, and it also

anticipates learning from the experience of developed countries, particularly Australia.

1.1.1 Circumstances

The Lao People's Democratic Republic (Lao PDR) or Laos is a landlocked country situated in Southeast Asia. The population is approximately 6,521,998 people with an annual growth average of 2.37% (CIA, 2007). The country is bordered by five other countries: the People's Republic of China and Burma to the north west, Thailand to the west, Vietnam to the east, and Cambodia to the south (Figure1. Map of Laos). The nation is bordered on the west by the Mekong River, the most important river for more than seventy million people who live along the river (Kristensen 2001). The Mekong River is the main source of food (rice crops, agriculture, and fish especially), transportation, communications and trade with other countries sharing the river (ADB, 2006; Kristensen, 2001). In addition, the main tributaries of the Mekong all have significant watersheds; these tributaries are used for hydroelectric power generation (ADB, 2004; Wong, 2004).

Figure 1.1: Map of the Lao PDR



(Source: World Bank, 2008)

Laos has a total land area of 236.800 square kilometres (km_2) with largely mountainous topography and thick forest (ADB, 2006; CIA, 2008). The mountainous landscape widens across the most northern part of the country (WHO, 2005). The central and southern parts of the nation are plateaus and plains with heavy pollution compared to the northern area (Wong, 2004). Administratively the country is divided into sixteen provinces, one municipality, and one special region (Regional data exchange systems, 2008). The capital city of Laos is Vientiane which is located in the central part of the country (Wong, 2004).

Laos has a tropical monsoon climate which is characterized mainly by two distinct seasons - a rainy season from May to October and a dry season from December to April (ADB, 2006). The natural hazards are flooding and drought which occur frequently (CIA, 2008). For the period of the wet season, areas of greater altitude can receive rainfall of more than 3000 mm annually (Wong, 2004). Due to relatively low altitude, Vientiane receives an annual rainfall of between 1500 mm and 2000 mm (Wong, 2004). The annual average temperature range is approximately 28 °C to a maximum of 38 °C (Regional data exchange systems, 2008). However, during winter in the mountainous areas, the temperature drops to around 14 to 15 °C (Regional data exchange systems, 2008).

Laos is in the group of least developed countries (LDC) with 30.7% of the population below the poverty line (CIA, 2008). The country is currently ranked 133rd out of 177 countries and thus categorised within the "Medium Human Development" category (UNDP, 2008). The Lao government has ambitiously planned to lift the country's status to be out of poverty and no longer in the list of LDC by 2020 (Regional data exchange systems, 2008). A GDP per capita was estimated at US$ 1,900 with 7% of the real growth rate in 2007 (CIA, 2008). However, the literacy rates of people aged fifteen and over averaged 58.7% and the unemployment rate was approximately 2.4% in 2005 (CIA, 2008). Although health indicators have been improving gradually over the past three decades, the efforts of the national authorities still remain under international standards, being the lowest in the region (WHO, 2005). A quarter of the population has no access to health services and nearly half live without access to clean drinking water (WHO, 2005). The estimated life expectancies in 2005 were 63 years for women and 59 years for men and the

estimated maternal mortality was more than 400 per 100 000 births. This was higher for females aged between 15-39 years, and it was even higher with those aged between 30-39 years (NSC, 2005).

From an economic perspective, Laos is largely an agricultural region with about 80% of its labour force employed in the agriculture sector, while the industry and services sector employs around 20% (estimated in 2005) (ADB, 2006; CIA, 2008). Laos depends a lot on foreign aid and imports a large number of its manufactured goods, medicine and machinery (DEFAIT, 2003 cited in Wong, 2004). The Lao economy benefits from investments in hydropower, mining, and the construction of hydroelectric dams. The latter is one of the strong economic drivers (CIA, 2008). In addition, the export commodities are mainly hydroelectricity, timber, copper and gold, coffee, wood products and textiles (CIA, 2008).

Laos has an underdeveloped infrastructure, especially in rural areas. Although the Lao government has support from Japan and China to improve the road system, it has no railroad, only a basic road system, limited external and internal telecommunications (CIA, 2008).

In addition, because of climatic and topographic conditions, SWM is a largely neglected subject. Low awareness and education on SWM result in inappropriate handling of waste, for instance, through burning and dumping which produce health risks for all communities. The country's rivers, especially the Mekong River, are critical to the population's livelihoods. However, the rivers are still used as a dumpling ground for waste, so that during the rainy season, when flooding occurs, the dumped waste is redistributed into residential areas. These practices produce widespread and negative health effects.

1.2 Study Objectives

The main objectives of this thesis are to:

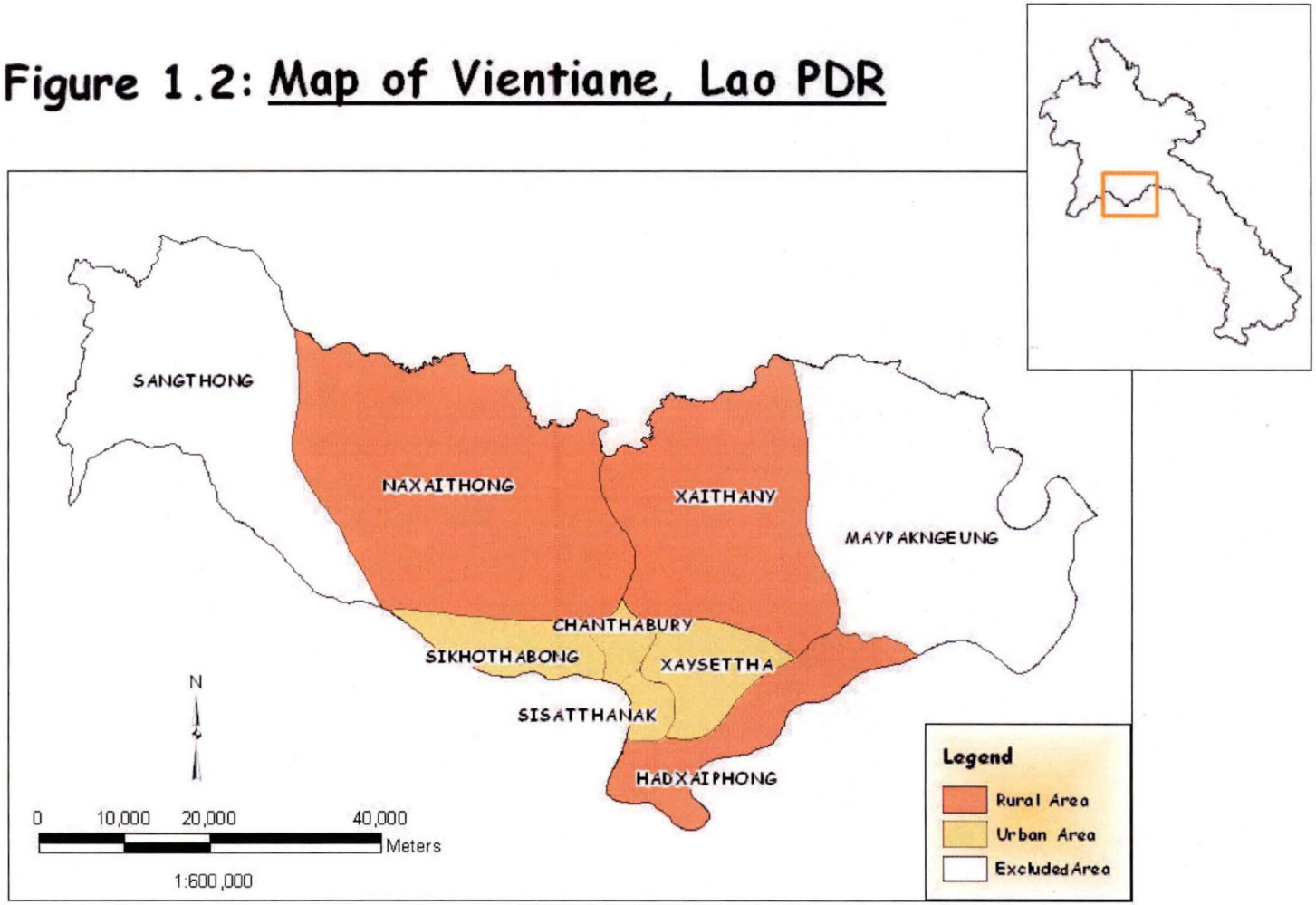
- review the relevant literature associated with solid waste management;
- explore solid waste management practices in Australia

- collect information on the ongoing status of solid waste management activities in Laos;
- explore the relevant regulations and legislation in Australia and Laos with are associated with solid waste management and the roles these play in order to encourage environmental improvement;
- critically examine the key challenges and hurdles to solid waste management in Laos;
- provide recommendations on how to improve waste management in Vientiane, based on the case study results;
- learn from the experience of a developed country, using the example of Australia.

1.3 Study area

The survey was undertaken in the Vientiane Municipality, Lao PDR. There are nine districts in Vientiane, divided into two areas: the urban and rural area. The four districts in the urban area are Chanthabury, Sikhothabong, Xaysettha, and Sisatthanak. For rural area, there are five districts: Naxaithong, Xaithany, Hadxaipong, Sangthong, and Maypakgeung (see figure 1). For the purpose of this thesis, two districts in the rural area are excluded: Sangthong, and Maypakgeung. The reason for this exclusion is because these two areas are far away from the research centre. Due to logistical and financial issues, this exclusion was deemed necessary.

Figure 1.2: Map of Vientiane, Lao PDR



1.3.1 A brief background on Vientiane

As mentioned before, the capital city of Lao PDR is Vientiane. It has a total land area of approximately 3,920 km^2 and is located on the Mekong river bank directly opposite Nongkhai province, Thailand (MacDonald, 2004; WEPA, 2008). As the Lao economy remains open to foreign investments, the prefecture of Vientiane is the centre for business and government. The city accommodates all of the foreign embassies, the presidential palace, government offices and non-government organisation head offices (MacDonald, 2004). In addition, many foreign businesses invest in several sectors, particularly in industrial factories, wood processing, textiles, and garment factories (Phouxay, 2007). Thus, urban migration seems to be increasing with the requirement for a bigger labour force and a number of young people have migrated from the countryside to the larger cities, particularly to the capital city, in order to improve their life, chances, career, and education (Phouxay, 2007). Since Vientiane has expanded rapidly, the city is facing a number of infrastructure-related problems such as traffic jams, sewerage disposal problems, and poor waste management. According to UNEP (2001), "such growth is known from experiences all over the world to lead to an exponential increase in urban environmental problems and stress the cultural fabric of the ethnically diverse country". People in rural areas, however, still remain in farming (ADB, 2006).

1.3.2 Population growth

In 2006, Vientiane city had a population of approximately 711,919 people with a 4.3% annual growth rate which is a lot higher than the national level which is around 2.5% (Khanal & Souksavath, 2005; NSC, 2007); this is a high growth rate compared to the neighbouring countries. Table 1 shows the comparison of population growth rates among the Mekong Subregion Countries. It is interesting that Laos and Cambodia have the highest population growth rates, followed by Burma. Basically, these three countries are in the group of least developed and low income countries. The majority of people in these three countries still continue to maintain high birth rates (Encyclopedia of the Nations, 2008). According to Becklake (1991), many countries in Asia have the greatest increasing populations because families have

many children in case they do not all service. The other Mekong subregion countries, such as Vietnam and China (particularly Yunnan province), had adopted policies to reduce the rapid rate of population growth (Jones, 1999); for example, one or two children per family. According to Jones (1999), Thailand has the highest level of urban dominance of any large countries in the world, with its urban population existing in the capital city (Bangkok). However, the low population growth rate in this country is mostly because of the urbanisation subverts the largely corporate family based way of life of traditional society and replaces it with individualism and growing personal objectives (Jones, 1999). The Urban Development Sector Unit (1999) states that socio-economic development, industrialisation, and urbanisation have an effect on the waste generation rates.

Table 1.1: Comparison of population growth rates in Mekong subregion countries.

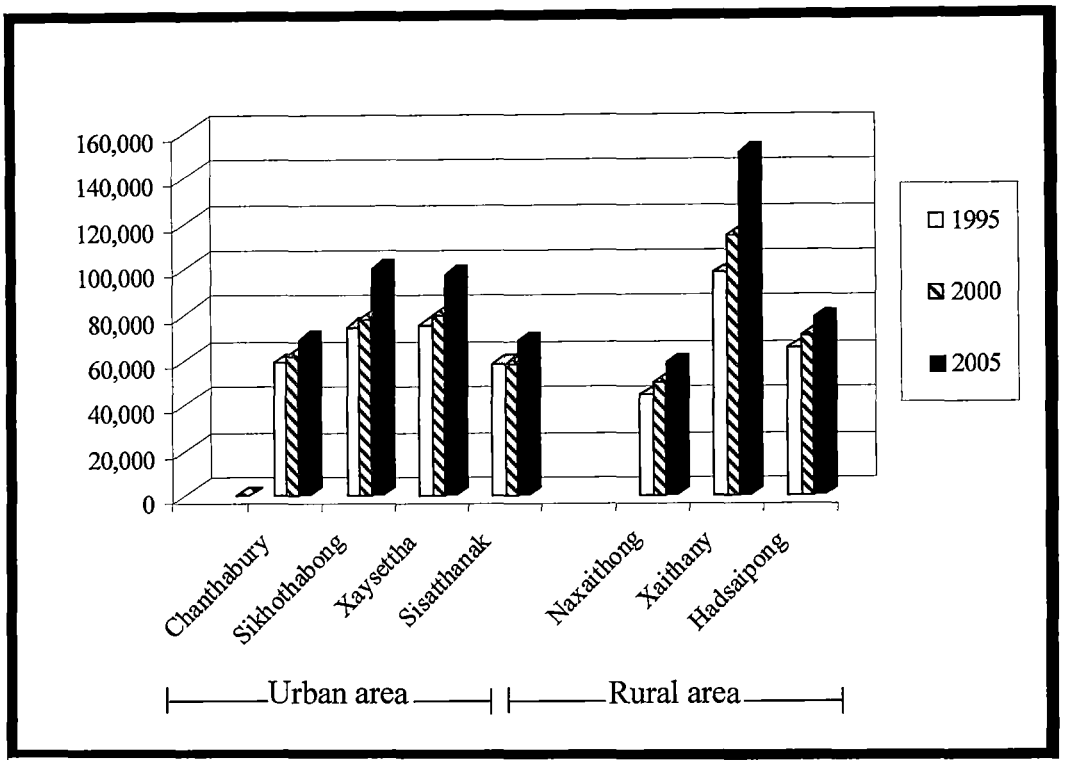
Country	**Population growth rate (%)**
Cambodia	2.5
Lao PDR	2.5
Burma	2.3
Thailand	0.8
Vietnam	1.6
Yunnan Province, China	1.2

(Source: ADB-UNEP, 2004 cited in Khanah & Souksavath, 2005)

In the past decade, the urban population has been increasing rapidly, mainly because of migration to towns (STEA & UNEP, 2006). According to Ababa (2006), the National Statistics Centre (NSC)[1] has been conducting population census surveys every ten years; the first census was conducted in 1985, and the second and third were carried out in 1995 and 2005. Since the population data from 1985 is not available, figure 2 represents the population in the whole city in 1995, 2000, and 2005 respectively.

[1] The National Statistics Centre (NSC) is a centre for social-economic statistics which provides Lao statistical data for all organisations, government, various sectors, local and other research.

Figure 1.3: Population data for Vientiane Municipality, Lao PDR in 1995, 2000 and 2005.



Source: NSC, (1995 & 2005); NSC (2000) cited in ESL (2004a)

Figure1.3 represents the Vientiane population data for 1995, 2000, and 2005 respectively. It can be seen clearly that the differences between the population in the urban areas and the least developed areas have increased rapidly at each census. The most significant item here is the high population in Xaythany district. In just fifteen years, the population in Xaythany district has increased from around 90,000 to almost 160,000 persons. On the other hand, in the Sikhottabong and Xaysetha districts in the urban area the population rose to almost 100,000 persons in 2005. The smallest population occurs in Naxaithong district which has risen less than 60,000 persons over the fifteen year period.

The rapid urbanisation has resulted in an increase of waste and this contributes to the problem. Thus, rising populations in urban cities of Lao PDR imply increased health risks due to existing methods of handling solid waste in the near to medium term.

1.4 Summary

In order to assess issues of SWM in Vientiane Municipality, this chapter provided an overview of Lao PDR, with a special focus on Vientiane background. As the population growth rate in Vientiane is one of the factors that contributes to the waste generation problems, a comparison of population growth rates in the Mekong subregion countries (Cambodia, Lao PDR, Burma, Thailand, Vietnam, and Yunnan Province, China) is provided. The differences between population growth rates in the Mekong subregion countries show that the group of least developed countries such as Lao PDR, Cambodia, and Burma are more likely to have higher population growth rates than others. This is because large families are perceived as necessary to provide labour and ensure support in old age. There is no policy for reducing population growth rate as in Vietnam and Yunnan province, China. Lastly, this chapter describes the increase in Vientiane's population for 1995, 2000, and 2005 respectively. The population growth has a direct effect on economic growth, industrialisation, and urbanisation in Lao PDR.

1.5 Thesis outline

This thesis is organised as follows:

Chapter 2 examines the literature to illustrate SWM theory and the complexities involved. These include collection and transportation, waste minimisation, treatment and disposal. In addition, the economics of solid waste is highlighted as an associated environmental problem.

Chapter 3 gives SWM background and SWM strategies in Australia. It focuses on SWM issues, the national policy and regulatory framework for SWM which include the national waste minimisation and recycling strategy, and state and territory government SWM policy and legislations. In addition, Australian local government environmental management is also illustrated.

Chapter 4 examines some of the SWM issues in Vientiane Municipality. It illustrates the legislative framework in Lao PDR and then focuses on the SWM initiatives and organisational involvement. It details SWM in Vientiane Municipality including responsibility for SWM, waste disposal and landfill sites, waste collection systems, and waste recycling.

Chapter 5 reports on a survey of SWM in Vientiane. It explains the methodology and interview process involving relevant stakeholders. These include the Vientiane Urban Development Administrative Agency (VUDAA), two private contractors: a.) Lao garbage company and b.) Chanthabury Cleansing Pvt. Company and lastly households. In addition, survey results and data analysis are also provided.

Chapter 6 concludes the research of both developed and developing countries such as Laos and Australia. Recommendations are provided by illustrating the best outcomes for solid waste management in Vientiane through the case study analysis as well as lessons from developed countries such as Australia.

1.6 The limitations of this research

Not many solid waste management projects have been undertaken in Lao PDR, thus there were difficulties accessing the relevant documents for references and analysis of the issues. In addition, a review of literature from different sources found only a few papers or studies relevant to this topic. These are projects of the Japan International Cooperation Agency (JICA) (2004) and the United Nations Development Program (UNDP) (2004) both of which employed Earth Systems Lao to undertake waste management studies in Vientiane. In addition, the research paper written by Bhoj Raj Rhanal and Bounsouk Souksavath (2005) proved helpful.

The survey which forms the basis of this thesis was carried out overseas, and a number of problems emerged during its conduct. These included communication problems, postage delay, difficulties in finding interviewers, and obtaining responses to questionnaires from government and private sectors.

Chapter 2: The Mountain of Waste

2.1 Introduction

2.1.1 Waste and problems associated with it

What is waste? We usually think that waste is just rubbish such as tins, bottles, paper and old food that are thrown in the rubbish bin (Becklake, 1991: 4), but in fact the definition of "waste" is more than that. According to Becklake, (1991: 3), "All living things produce waste". Waste is basically produced from households, industries and commercial enterprises. It can be defined as any product or substance that is no longer of use or value to people or organisations that own it and which will be discarded (Australian Government Productivity Commission, 2006: 2). Simply throwing things away creates pollution and is wasteful of the Earth's limited natural resources (Becklake, 1991). EPA NSW defines waste as "any matter, whether solid, liquid, gaseous or radioactive, which is discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration of the environment" (EPA NSW, 1996).

Even though waste is perceived to be a problem for many reasons, the three major reasons usually cited are: (i). disposal which can affect the environment and people's health; (ii). landfill space is claimed to be becoming scarce; and (iii). waste is the unused items of a life cycle process that can have upstream environmental and resource implications (Australian Government Productivity Commission, 2006:XXVII). I n general terms, poor waste management practices have a direct impact on public health, natural environment, and economy. Firstly, in terms of public health, poor waste management practices allow for the creation of serious health problems associated with disease-carrying pests, such as rats and flies (Birley & Lock, 1999, cited in Yousif & Scott, 2007). In addition, many households store their waste in open containers ranging from baskets to plastic bags, making home storage unhygienic (Boadi & Kuitenen, 2005). When improperly stored in open containers for long periods, waste becomes detrimental to health because it increases the breeding of disease–carrying vectors like rodents and insects (Boadi & Kuitenen,

2005). For instance, Domfeh (1999) asserts that poor garbage storage and sanitation results in diarrhoea in most third world countries. Secondly, Rogers (2005: 4) claims that the direct environmental impacts of solid waste are sobering. In particular, the greatest environmental threat of solid waste is from the landfill itself. According to Rogers (2005: 4), the increased amounts of waste mean more and more toxins are released into the environment, and contaminate the soil and water supply. The landfills also emit 'land-fill gas', due to the emissions of decomposing waste (Rogers, 2005: 4). This vapour consists mostly of highly flammable methane, which is a major contributor to global climate change (Cameron, 2008; Rogers, 2005: 4). Lastly, due to increasing solid waste generation, increasing land prices and more stringent environmental regulations, waste management is becoming more expensive (Qian & Burritt, 2007). For example, the urban areas of Asian countries currently spend around US$ 25 billion on SWM per annum; this figure will rise to at least US $ 50 billion in 2025 (Urban Development Sector Unit, 1999). In the long run, this increase in cost not only has a negative impact on the country's economy, it will also impact on the effective operations of the organisations involved in waste management (Qian & Burritt, 2007).

Therefore, due to this complexity of issues at hand, waste management is a challenging field. In other words, waste management often covers a truly wide range of disciplines from natural sciences and technology to social sciences and beyond (Bruner, 1996; Miranda, Miller & Jacobs, 2000). Indeed, while looking for solutions to waste problems, it is always necessary to address more than just one discipline (Bruner & Feliner, 2007).

2.1.2 Solid waste

Solid waste is best defined by what it is not- it is not waste-water discharges to surface water and is not waste air emissions (Beranek, 1992). Solid waste is any waste that someone would consider disposing of on the land (Beranek, 1992). In other words, solid waste is generated in offices, landscaping activities, homes, agriculture, construction and factories and includes waste from scrap metal to ash (Ayotamuno & Gobo, 2004; Becklake, 1991: 4; Beranek, 1992). Over the years, the

increased generation of large amounts of solid waste in the world is attributed to the rapid growth of cities both in developing and developed countries (Boadi & Kuitunen, 2005). Compounding this effect is the fact that modern societies are also known as 'throwaway societies'. Some of the characteristics of these societies are; economic prosperity which encourages people to buy more, which in turn increases waste generation; advertising which emphasises the short life-cycle of previous products, where the latest product is an improvement on all the others; and self-service cultures that wrap everything individually so that we can take the goods from the shelves ourselves (Becklake, 1991: 6). All of these factors have contributed to the increase in the level of solid waste generation over the past.

Since this study deals with municipal solid waste only, a more refined definition of solid waste will be used. According to EPA (1998: 18, cited in Lah, 2001), municipal solid waste includes waste such as durable goods, non-durable goods, containers and packaging, food scraps, yard trimmings, and miscellaneous inorganic waste from residential, commercial, institutional, and industrial sources. The greater the economic prosperity and the higher the percentage of urban population the greater the amount of solid waste (Urban Development Sector Unit, 1999). Examples illustrate the composition percentages of different types of waste in different regions. In Central America, the municipal solid waste consists of 43.8 per cent food waste, 13.7 per cent paper and cardboard, 13.5 per cent wood, 2.6 per cent textiles, 1.8 per cent rubber/ leather, 6.7 per cent plastic, 2.6 per cent metal, 3.7 per cent glass, and 12.3 per cent other (ash, dirt, dust, soil, electronic waste) (Intergovernmental Panel on Climate Change, 2006). In contrast, municipal solid waste in Eastern Asian countries consists of 26.2 per cent food waste, 18.8 per cent paper and cardboard, 3.5 per cent wood, 3.5 per cent textiles, 1.0 per cent rubber/ leather, 14.3 per cent plastic, 2.7 per cent metal, 3.1 per cent glass, and 7.4 per cent other (Intergovernmental Panel on Climate Change, 2006). In addition, municipal solid waste is further classified into several categories such as residential, industrial, institutional, and construction and demolition (Urban Development Sector Unit, 1999). However, for the purpose of this thesis, all of the above is considered as municipal solid waste.

In Australia, a portion of solid waste has been designated by the government as 'hazardous waste' (Scott, Beydoun, Amal, Low & Cattle, 2005). In general terms, hazardous waste is defined as waste that requires treatment before it is suitable for disposal to landfill (Beranek, 1992, Nathanson, 1986: 373; Scott et al., 2005). Examples of hazardous waste include medical waste from hospitals, fertilisers, paints, and cosmetics (Becklake, 1991: 18; Beranek, 1992; Nathason, 1986: 337). In Australia, although all states specify the separate disposal of hazardous wastes, variations exist between states as to what constitutes a hazardous waste, and the acts and regulations that control them (Scott et al., 2005). Having said that, hazardous wastes in Australia are generally categorised according to their basic properties of toxicity, reactivity, ignitability, and corrosivity (Chayabutra, 1994). It is not the intention of this thesis to focus on hazardous solid waste, hence, solid waste will be considered to be the more common type of municipal waste, as alluded to earlier.

The purpose of municipal solid waste management is to protect public health, prevent congestion, and preclude unpleasant odours and aesthetically offensive scenes by removing these wastes from point of origin and disposing of them in a safe and acceptable way (Beede & Bloom, 1996: 177). Therefore, with this notion in mind, the following discussion will focus on the management of solid waste.

2.2 Solid waste management

Scholars recommend the implementation of an integrated waste management hierarchy in order to achieve sustainable solid waste management (for example, see, Price & Joseph, 2000). Indeed, review of the literature on solid waste management shows that this system has been favoured by many developed countries such as the United States (for example, see, Lah, 2001), Australia (for example, see, Chayabutra, 1994) and developing countries as well, such as Panama (for example, see Linowes & Hupert, 2006) and India (for example, see, Zia & Devadas, 2007). The solid waste management hierarchy was designed to provide a framework by which municipal solid waste is reduced or managed through several different practices (Price & Joseph, 2000). Although this strategy may be tailored depending on a particular

community's needs (Lah, 2001; Yousif & Scott, 2007), the basis of this strategy consists of (Price & Joseph, 2001; Urban Development Sector Unit, 1999):

- Collection and transport
- Waste minimisation
- Treatment and disposal (recycling, composting, landfilling, incineration with energy recovery)

2.2.1 Collection and transport

The primary aim of waste collection and transportation is to transport wastes to a disposal site at minimum cost in order to prevent any risk to public health and the environment (Siklossy, 1993). In essence, the method of collection, number and type of collector trucks, and the number of workers involved are crucial factors in waste collection (Angelelli & Speranza, 2002). In Australia, solid waste collection is generally a local municipal service provided to residents (Australian Government Productivity Commission, 2006: 42), where residents place their waste in one or more bins. This waste is collected in trucks and taken to various facilities to be reused, recycled or disposed of (Australian Government Productivity Commission, 2006: 65). In addition, the practice of separating waste into a number of bins (typically recyclables and general waste) requires time and effort on the part of the householder, and as such it imposes nonmonetary costs on them (Australian Government Productivity Commission, 2006: 46). Waste collection and transportation in Australia can be conducted either by municipal management or by private contractors (Worthington & Dollery, 2001). In general, these different arrangements can be grouped into four categories: municipal, where the local authority manages the entire system; private contract, where private operators bid for contracts to manage all or part of the system; private collection, where private operators bid for contracts with individual householders; and franchise, where private operators are awarded monopolistic franchise over an entire area (Corbitt, 1990 cited in Chayabutra, 1994).

In general, there are three waste collection methods. The first method is referred to as the traditional method, where a truck with a three-man crew drives from one house to another as two men empty dustbins or throw rubbish bags into the rear of the truck (Angelelli & Speranza, 2002). This method is still used in many developing countries. The primary shortcoming of this method is that it requires a large number of crew to do the collection, hence increasing the collection cost (Angelelli & Spreranza, 2002).

The second method, known as the side-loader system, requires residents to place their garbage bins on the streets, and the collecting truck will stop beside each container and, by means of a semi-automatic system operated by the driver from the cabin, it lifts and empties the bins into the truck's body (Angelelli & Speranza, 2002). This system requires the lowest number of crew, it collects more rubbish in a single operation as compared to the traditional system, is faster and does not involve the division of a collection area into neighbourhoods (Angelelli & Speranza, 2002). However, the main drawback of this system is it often results in litter being left where bags have been ripped or interfered with by animals (Chayabutra, 1994). This is by the far most popular waste collection method in Australia.

The third method is the communal collection (Chayabutra, 1994), where the municipality provides large containers at designated areas for residents. In Australia, this method is still practised in rural areas and areas that are far away from local infrastructure. The drawback of this system is it could be expensive for the operator due to the long distances travelled and the time involved (Chayabutra, 1994). In addition, this method is inconvenient for residents because they need to travel to a central location in order to dispose of their waste.

2.2.2 Waste Minimisation

According to EPA (1998, cited in Lah, 2001), waste minimisation is referred to as any change in the design, manufacturing, purchase or use of materials or products (including packaging) to reduce the amount of waste before it enters the municipal waste management system. In other words, waste reduction activities

affect the waste stream before the point of generation, while recycling, combustion and landfilling are the management options after the point of generation (Phillips, Adams, Read & Green, 2000; Price & Joseph, 2000; Read & Phillips, 1998). Waste minimisation has been regarded by some as too idealistic to feature within the solid waste management strategy (Price & Joseph, 2000). However, the best way to achieve more sustainable waste management is the reduction of waste at source (Phillips, Clarkson, Adams, Read & Coggins, 2003). Although waste minimisation is at the top of the waste management hierarchy, it is almost the most difficult to implement. Scholars argue that reform of education and information strategies are essential in order to increase the awareness of the importance of waste minimisation (Price & Joseph, 2000; Waite, 1995). Having said that, this strategy has also been successfully implemented. A good example can be drawn from Northamptonshire in UK, where the local council, in partnership with 22 companies, developed a program that concentrates on resource efficiency and dramatic waste reduction, and increased the production of more first class product per unit of resource (Phillips et al., 2003). After 24 months, the companies not only saved 3.5 million pounds, they also reduced their waste output associated with production by at least 20 percent (For full details, refer to Phillips et al., 2003), hence, greatly reducing waste generation.

2.2.3 Treatment and disposal

The most common method of waste disposal world wide is landfilling. This option is generally viable for a community with a long life-span landfill (Yousiff & Scott, 2007). Other methods are composting, recycling and incineration. The strengths and weaknesses of each method are shown in Table 2.1 (Commission of the European Communities, 1982, cited in Chayabutra, 1994).

Table 2.1: The strengths and weaknesses of waste treatment and disposal methods

System	Strengths	Weaknesses
Landfill	Low cost operation High operational reliability Flexible	Requires suitable site Less benefit from waste
- with compacting and shredding	Reduces cover material and site	More expensive than normal
Composting	Reclamation of about 50%	Commercial outlets required
Incineration	Sterilisation and significant reduction of waste to tip	High cost
- with energy recovery	Overall cost reduced	Requires high volume of waste
Recycling	Reduced waste to tip Reduced resource demand	Temporary disposal May raise indirect costs

(Source: Commission of the European Communities, 1982, cited in Chayabutra, 1994)

Landfill:

Landfills are generally considered to be the most economic means of waste disposal available, and depending on location, up to 95% of solid waste generated worldwide is landfilled (Scott, Beydoun, Amal, Low & Cattle, 2005). The concept of landfill has undergone significant changes over the last century (Scott et al., 2005). The changes to the features of landfill result directly from factors such as the generation of greater loads and varieties of wastes, and a greater public awareness of the potential harmful effects of landfill on the local environment (Ramboll, 2007). As a case in point, past landfill sites were often shallow and small in area, and compaction of deposited wastes was virtually unheard of (Scott et al., 2005). Aerobic degradation of organic matter predominated in these systems (Scott et al., 2005). In most modern landfill, waste usually undergoes compaction as it is deposited and is decomposed primarily by anaerobic processes (Scott et al., 2005). Nowadays, the most common methods for landfilling are open dumping, sanitary landfill, and secure

landfill (Ramboll, 2007). Open landfills have a low management cost, but result in a lot of pollution (Chayabutra, 1994). Typically, these landfills are located in areas where the risk that they will cause damage to human health and the environment is reduced to acceptable levels (Australian Government Productivity Commission, 2006: 68). Once they reach the end of their operational life, they are restored and used for recreational or other purposes (Ramboll, 2007). The main drawback of open dumping and sanitary landfill is that it is practically impossible to keep the hazardous waste within landfill sites (Becklake, 1991: 19). Therefore, secure landfills are often used to treat hazardous waste to prevent detrimental effects on the environment (Department of Primary Industries, Water, and Environment, 2004).

In terms of municipal solid waste landfills, the waste deposited in these landfills generally derives from households, offices, and small businesses and they do not accept many forms of hazardous waste (Scott et al., 2005). Nevertheless, the items that originate from these seemingly benign sources often contain toxic substances. As they break down, they can release their toxic constituents into the leachate (Musson, Jang, Townsend, Chung, 2000).

Composting

On the large scale, composting involves separating out the organic decomposable material from waste, shredding or pulverising it to reduce its particle size, and digesting it through a window method (Russell, 1982: 134; Zbinden & Goodman, 2007). This decomposition of organic waste results in a humus-like substance which is primarily used as a soil conditioner (Russell, 1982: 134). On the small scale, composting is often referred to as backyard composting of biodegradable organic waste (Lah, 2001). Either large or small scale, the disadvantage of composting is the production of odours, harmful gases such as methane and nitrous oxide; pollution of ground water and soil; and the attraction of pests and pathogens to the area (Hobson, 2007).

According to Russell (1982: 135), the greatest threat to composting of solid waste is because there are limited markets for composted products.

Incineration

In simple terms, incineration is the burning of waste. This is a popular method in many countries such as Japan, Denmark, Sweden, and Switzerland, because this can reduce the amount of solid waste by about 80 to 90 percent (Becklake, 1991: 12). In addition, a properly designed incinerator that operates under suitable temperatures and conditions can generate heat or electricity for the nearby areas (Lah, 2001; Price & Joseph, 2000; Russell, 1982: 135). At the present time, incineration is the only suitable method for intractable wastes and has gradually attained better efficiency and less emission of toxic residues (Chayabutra, 1994). However, incineration also has its harmful environmental impacts (Price & Joseph, 2000). Firstly, proportionately more energy is needed to produce smaller units of energy. In other words, the resources required to install, run and maintain an incinerator will be more than half those needed to run a similar-size generator (Price & Joseph, 2001). Furthermore, for every ten tonnes of waste burned, one tonne of ash remains (Becklake, 1991: 12). This may still contain harmful materials which pollute the environment when the ash is buried in landfill sites (Becklake, 1991: 12).

Recycling

Recycling is the activity by which discarded materials that are no longer useful are accumulated, sorted, processed, and converted into raw materials and used in the production of raw products (EPA NSW, 1996). Before recyclable materials can be processed, they must be collected. Most recycling involves curbside recyclables collection, drop-off programs, buy-back operations, and/or container deposit systems (Lah, 2001). The success of the recycling process needs a system of source separation and careful handling (Pollock-Shea, 1988). In other words, it is necessary to distinguish between quantity and quality (Pollock-Shea, 1988). For instance, paper rapidly loses its value when combined with other trash, particularly organic food waste and thereby does not command a good market price. Indeed, according to Pollock-Shea (1998), the cleanest discarded materials always command the highest prices and value.

The benefits of recycling are resources conservation (eg. trees), reduced energy consumption (eg. making paper from used paper instead of virgin timber reduces the energy used for production by almost 70 percent and requires less than half as much water), and lower water and air pollution (Pollock-Shea, 1988; Price & Joseph, 2000). In addition, recycling offers communities an opportunity to trim their waste disposal needs, and thereby reduce disposal costs and reduce the demand on the size of increasing landfill (Pollock-Shea, 1988). However, in many areas of the world, there are barriers to recycling such us prejudice against use, or post-consumer materials; and weaknesses in secondary material markets (Gandy, 1993). In other words, the economic viability of the recycling option depends largely on the availability of secondary markets for recovery products or materials (Australian Government Productivity Commission, 2006: 81; Department of Environment, Queensland, 1996; Russell, 1982: 78).

The other main challenge of recycling is that many residents are still unsure of what can be recycled and how to present items before placement in the bins. This is evidenced by the fact that many items that are not recyclable such as garden waste, ceramics etc are found in recycling bins (Christchurch City Council, 2006). In addition, the recyclable items are poorly presented such as caps and lids still attached to containers, and the containers are not thoroughly rinsed (Christchurch City Council, 2006).

2.3 The economics of solid waste

There are many different sources of funds for SWM. In general, these are positively correlated to SWM decision making that is based on a particular method for determining the appropriate price of waste management services (Bureau of Industry Economics, 1993: 32). Indeed, literature on SWM identifies an array of costs that have an important impact on the sources of funds for SWM. Morris & Holthausen (1994) suggest the usage of household production models as a means of analysing and evaluating the household component of a variety of waste management initiatives, such as changes in financing of waste collection service, recycling requirements and collection options offered; they have a direct impact on the funding

of solid waste management. In similar vein, Beede & Bloom (1995) suggest several mechanisms that may affect funding for waste management. These are the effects of income and demand for environmental quality (Beede & Bloom, 1995). For instance, they assert that high-income households are likely to demand more for environmental quality than low-income households, and thus are willing to pay more for it (Beede & Bloom, 1995). Quite differently, Bose & Blore (1993) suggest the funds for solid waste management should incorporate total costs, including the opportunity cost of landfills and the costs associated with various externalities, such as diminished neighbouring property values and environmental risk costs.

Recently, there has been consideration of the possibility of financing waste management through unit charges rather than property taxes as a means of bringing about a reduction in societal waste production. More importantly, without the unit charges for garbage, individuals do in fact perceive the marginal cost of the waste management services they receive to be zero and therefore have no incentive to change their waste production level (Ferrara, 1999).

Despite a wide array of literature pertaining to the economics of SWM, the fundamental sources of funds for SWM are generally clustered around sources such as property taxes, separate property taxes, service charge fees, can or container rental charges, special assessment and miscellaneous revenues (American Public Works Association, 1966, cited in Chayabutra, 1994). The rate bases for SWM through property tax are generally estimated by combining two or three different measures; these are generally measured by uniform charges for each service, number of rooms, dwelling, units or apartments, frequency and service provided, size and numbers of containers (Chayabutra, 1994). With regards to residential properties, service charges are usually based on number and size of containers, collection method, frequency and distance of the waste collection (Australian Government Productivity Commission, 2006: 66), whereas commercial rates are usually based on quantity, frequency of collection, kind of business, square footage or flat rate, and large container services (Bernstein, 1991).

Although the success of financing SWM relies heavily on how municipalities collect service charges for funds, each municipality uses different methods in collecting charges (Bose & Blore, 1993). Within Australia for instance, the variations

in charges for solid waste collection are influenced by a number of factors such as the number of dwellings, the nature of the streets to be negotiated, the distance from collection area to the disposal site and the productivity of the collection crew (Bureau of Industry Economics, 1993: 51). In addition, metropolitan dwellers are often charged higher compared to rural residents (Bureau of Industry Economics, 1993: 63).

Within Australia, general tax revenues collected by local governments have funded SWM (Australian Government Productivity Commission, 2006: 42). The greatest tax revenue is derived from the sector that collects and transports waste (64 percent); followed by the processing, treatment and/or disposal sector (27 percent); and the collection and transport of recyclables sector (6 percent) (Australian Government Productivity Commission, 2006: 42). This general tax revenue is derived from both private firms and government trading enterprises (Australian Government Productivity Commission, 2006: 42).

2.3.3 Charges

According to Bernstein (1991), three types of charges apply to the collection and disposal of solid waste: user charges, disposal charges, and product charges.

User charges. This type of charge is usually based on the volume of waste collected (Australian Government Productivity Commission 2006: 229). In most cases, the charge is calculated to cover total expenditures of collection and treatment of municipal solid waste, and does not reflect the marginal costs of environmental effects (Bernstein, 1991). In some instances, some municipalities implement this system as an incentive for households to reduce waste production (Kelleher & Dixie, 2000). For instance, Houtven & Morris (1999) found that this charging strategy in Georgia, United States has resulted in a 36 percent reduction in waste generation by households. However, the most common problems associated with this strategy are disagreement over the charge base, high monitoring cost (Bernstein, 1991), and the increase in the illegal dumping rate (Fullerton & Kinnaman, 1996).

Disposal Charges. These charges are based on the type of waste and the method of treatment before dumping (Bernstein, 1991). For example, incinerated and composted waste attract a lower rate than landfilled waste (Bernstein, 1991), because it is necessary to treat landfilled waste for leachate emission and other environmentally harmful polluters.

Product charges. Most product charges on waste have applied to non-returnable containers, lubricant oils, plastic bags, fertilizers, tyres, and feedstock (Bernstein, 1991). Special charges and taxes that compose these product charges are often levied on these polluting products to influence firms or households' behaviour, aiming at either reducing the quantity produced, or at decreasing the amount of effluents (Bernstein, 1991; Morage-Gonzalez & Padron-Fumero, 2002). For instance, in Sweden and Norway, product charges are applied to batteries, fertilizers, and pesticides (Morage-Gonzalez & Padron-Fumero, 2002). However, most product charges systems lack actual incentive impact because they rely heavily on direct monitoring and regulation by government (Bernstein, 1991).

2.4 Summary

This chapter describes the waste and problems associated with it. Subsequently, it describes the concept of solid waste, followed by its management. With regards to SWM, its strategies in terms of waste hierarchy such as collection and transport, waste minimisation, treatment, and waste disposal are discussed. In general, waste hierarchy was designed to provide a framework to reduce and better manage solid waste. Finally, the economics of solid waste is discussed in respect to the sources of funds such as charges, that are associated with SWM.

Chapter 3: Solid Waste Management in Australia

3.1 Overview of solid waste management in Australia

Like many developed countries, Australia has become increasingly concerned about the relationship between environment and development. These concerns are based on the fact that several important environmental issues are land-use related and are tied to growth (Chinitz, 1990; O'Gallagher, 1990: 1). Specifically, Australia is now at a stage where SWM choices are fast becoming as important a competitive development factor among communities as water management, reliable electricity, sewer capacity, buildings, and other infrastructure (Beranek, 1992; Keen & Mercer, 1993). In this context, good SWM choices and management have become major foci of development, particularly within the context of sustainable development (Keen & Mercer, 1993).

Along with the growing urban population in Australia in recent years, waste generation has grown rapidly (Qian & Burritt, 2007). It is estimated that more than 26.7 million tonnes of solid waste is collected and disposed of in landfills each year nationwide (Australian Bureau of Statistics, 1998). More startling is the fact that the study suggests that Australia's level of solid waste generation per capita is one of the highest in the world (Environment Australia, 2001 cited in Qian & Burritt, 2007). Given the limited capacity of the ecosystem and environmental impacts of solid waste disposal on the ecosystem, the increasing quantities of waste have become a critical problem challenging sustainable development (Qian & Burritt, 2007).

Therefore, more recently, SWM strategies in Australia have become concerned with broader issues of sustainability and conservation, rather than just focusing on end-of-pipe or downstream solutions (that is, waste disposal) (Australian Government Productivity Commission, 2006: 11). Indeed, a waste hierarchical approach of avoidance, reduction, recycling, energy recovery and disposal, has been adopted (Australian Government Productivity Commission, 2006: 11).

Stemming from that notion, this chapter briefly explains the SWM strategies adopted in Australia, followed by policy and regulatory frameworks that are related to these strategies, and lastly the role of local government in planning and managing solid waste in Australia.

3.2 Solid waste management strategies in Australia

As mentioned earlier, the philosophy for SWM in Australia adopts a waste hierarchical approach that focuses on avoidance, recycling, energy recovery and lastly disposal. In this approach, a proper strategy for SWM for individuals, businesses, and communities is one that addresses as much of the solid waste at the highest level on the hierarchy as possible (Hubick, 1991: 2). Indeed, the presumption underpinning the waste hierarchy is that the environmental costs are generally lower if waste is avoided altogether and higher when waste is disposed to landfill (Ackerman, 2005: 2). Having said that, according to Beranek (1992), options that are successful in one country may not be successful in another due to economics or other social factors such as prevailing attitudes (Beranek, 1992). Therefore, the purpose of this section is to critically examine each option in Australia and its strengths and weaknesses in the Australian context.

3.2.1 Waste avoidance

According to Environment Australia (1997: 49), waste avoidance refers to the complete removal of some materials from the waste stream and may involve changes to production processes. In this part of the hierarchy, resource conservation is generally accepted as a major environmental benefit resulting from waste minimisation (Environment Australia, 1997: 5). For waste avoidance, the main initiative is education such as increasing community awareness and cooperation (Beranek, 1997). In Australia, some of the measures that have been implemented by local, state and commonwealth governments are providing initiatives for businesses to remove unnecessary packaging from products and changes in product design to reduce materials consumption, encouraging consumers to purchase products that use

appropriate packaging and reusable or refillable products (Environment Australia, 1997: 50). The strength of this method is that it is the best way to achieve sustainable SWM as it can prevent many negative environmental impacts of SWM compared to other methods such as landfilling.

However, success in terms of implementing this strategy is hard to quantify because of there being so many reasons for waste stream fluctuation and also because it is hard to measure the success rate of 'educating' communities about waste avoidance (Beranek, 1997). Indeed, according to the Australian Government Productivity Commission (2006: 147), in order to maximise net benefits to the community, SWM policy should be guided by rigorous analysis of the financial, environmental and social costs and benefits, not by the simple priorities suggested by the waste hierarchy. In other words, without any measurable standards or benchmarks, waste avoidance strategies can be viewed as aspirational targets at best, as opposed to legally binding regulations. Therefore, it is difficult to assign accountability to the parties involved, as well as consequences for targets not being met (Australian Government Productivity Commission, 2006: 154).

In short, the zero waste targets tend to be aspirational goals or arbitrary targets rather than strategic and comprehensive strategies. More importantly, in Australia, the evidence shows that chasing this zero waste target has a very high cost and is technically, financially and administratively complex (Australian Government Productivity Commission, 2006: 150). Therefore, in Australia, this approach is not widely endorsed compared to other SWM strategies.

3.2.2 Waste reduction

According to Environment Australia (1997: 53), waste reduction refers to changes to a product or process that reduce the amount of waste produced, that is, situations where it is not viable to avoid the production of some waste. In Australia, some identifiable examples of waste minimisation include:

- Packaging materials are constantly being redesigned to reduce the amounts of materials necessary to achieve this goal. Plastic bottles made of PET now require

15% less material than the original product which was introduced in 1978 (Hubick, 1991: 31).

- The glass industry is constantly responding to this challenge as well. In Australia, the 'stubby' beer bottle produced by ACI Glass Packaging weighed 260g in 1980 but only 170g in 1990 (Hubick, 1991: 31).
- Various councils have adopted differential pricing strategies across Australia. These initiatives are mainly based on the justification from research by Recycle NSW in 1993 that indicates that larger garbage bins resulted in more waste being diverted into the bin (Litter and Recycling Research Association, 1993). These initiatives include (Environment Australia, 1997: 54):
    - *Pay by volume*- Charging households according to the size of bin they select.
    - *Bag or tag systems*- Similar to volume based systems, but the charge levied relates to actual volume generated rather than the volume available.
    - *Pay by weight*- Charging households based on the weight of waste collected.
    - *Rebate systems*- Householders pay for a standard service level and then receive a rebate (reward) for using the service less often.

However, the main disadvantage of these strategies is they are not easy to implement. This is because the options available need to be balanced against other criteria such as community expectation, type of waste, incidence of illegal dumping, and other problems such as 'stomping' on bin contents (Environment Australia, 1997: 53). Indeed, to cite one example, the Australian Government Productive Commission (2006: 145) states that solid waste such as glass, plastics and aluminium and ferrous metals is largely inert in landfills and is not a significant contributor to leachate, therefore produces few or no externalities in landfill. Therefore, seeking to move such waste 'up the hierarchy' would impose net costs on the community if additional costs incurred by disposers are not offset by the benefits of reduced environmental externalities (Australian Government Productivity Comission, 2006: 146).

In short, Australian councils do not widely endorse the waste avoidance and minimisation approaches, rather, they are regarded as indicative priorities intended to

guide waste management policies (Australian Productivity Commission, 2006: 143). The reason is that strict adherence to the waste hierarchy list of preference can lead to waste management outcomes that are unsuitable for the circumstances, costly to the community, and risk circumventing the study of all relevant costs and benefits required in order to develop sound SWM policy (Australian Productivity Commission, 2006: 143).

3.2.3 Waste recycling

Recycling is the process of converting products back into their constituent raw materials and then reprocessing this raw material into new articles (Environment Australia, 1997: 63). The impetus for recycling is the need to conserve natural resources and to protect the environment (Institution of Municipal Engineers, 1991: 11). As mentioned earlier, however, different properties of various materials determine their suitability for recycling, as not all materials can be recycled indefinitely (Pollock-Shea, 1998). In some cases, recycling reduces the quality of a material, so it is not always possible to produce the same articles that are provided from the source material (Organisation for Economic Co-operation and Development, 1983: 20). In addition, recycling success is also determined by the fact that recycling cost does not outweigh the anticipated benefit, and demand exists for the finished product (Institution of Municipal Engineers, 1991:11; Pollock-Shea, 1998). In other words, councils must first seek a reliable outlet for the products of recycling and establish that the required standards of cleanliness, consistency and absence from contaminants are achievable within the collection routines to be adopted (Institution of Municipal Engineers, 1991: 11).

In Australia, a range of municipal recycling activities is undertaken, including kerbside, and approximately 90 percent of Australian household have access to kerbside recycling for paper and packaging; and many others can drop off their recyclables at depots (Australian Government Productivity Commission, 2006: 79). While municipal recycling in Australia is common, only 20 percent of Australia's recycled materials are recovered from municipal waste (Australian Productivity Commission, 2006: 42).

In Australia, although the recycling rates have increased over the years, research by Harrison Market Research (2005), suggests that the recycling program in Australia is one of the most successful in Organisation for Economic Cooperation and Development (OECD) countries. The main contributors to this success are the Australian public's perception of the importance of recycling activities and the strength of market demand in Australia and internationally for recovered materials compared to virgin materials (Australian Bureau of Statistics, 2003). In addition, the use of a marketing network has proven very successful in developing markets for recycled materials in Australia (Nicholson, 2005). These marketing networks consist of members with common goods and/or services and facilitators that assist in the development of new and existing markets for the members' products (Nicholson, 2005). These marketing networks (in essence, also the recycling companies), with the support of local governments, have created the demand for recovered materials both locally and internationally by driving the prices of recovered materials below the virgin materials (Australian Government Productivity Commission, 2006: 24). Also, with the support of local governments, recycling companies have thrived, with operations ranging from recovery of cardboard and glass to organic waste and oil (Environment Australia, 1997: 64). Having said that, the success of recycling also needs to be balanced by the location of recycled products and the stability of recycling markets (the main contributing factors) (Environment Australia, 1997: 67).

3.2.4 Energy recovery

Energy recovery refers to the use of waste products as a source of fuel (Environment Australia, 1997: 76). In Australia, the most likely opportunity for councils to recover energy from waste is by designing and operating local/regional landfills to optimise landfill gas generation and recovering it for electricity generation (Environment Australia, 1997: 76). According to the Department of the Environment and Heritage (2005), between 1990 and 2003, the proportion of landfill gas that was captured and converted into energy grew from almost zero to approximately 24 percent; with 75 percent of this generated electricity servicing major urban areas and capital cities. Although landfill-gas capture does not represent a significant energy source for Australia (Australian Government Productivity

Commission, 2006: 33), the growth in landfill-gas capture has occurred due to government incentives, regulatory requirements promoting the generation of electricity from renewable sources, attempts to reduce greenhouse gas emissions from landfills, and commercial incentives (Department of the Environment and Heritage, 2005).

3.2.5 Waste disposal

In Australia, the current state of technology and comparative cost of alternative methods to landfill suggest that approved and managed landfill is the most appropriate means of solid waste disposal (Australian Government Productivity Commission, 2006: 68). More than 90 percent of all solid waste generated in Australia is disposed of in landfill (Scott et al., 2005). In 1993 it was estimated that each year more than 14 million tonnes of refuse, representing 95% of the total, is disposed of in Australian landfills (Scott et al., 2005). By 1996-1997 this had increased to 21.2 million tonnes, 33 tonnes corresponding to a per capita disposal of 1.1 tonnes per year and placing Australia among the highest 10 solid waste generators within the OECD (Scott et al., 2005). However, the amount of waste disposed to landfill in Australia as a proportion of total generated, appears to have fallen (Australian Government Productivity Commission, 2006: 68). For example, landfill-disposal rates decreased from 60 percent to 45 percent and 67 percent to 27 percent respectively, in Victoria and the ACT between 1994-95 and 2004-05; potentially for the same reasons that recycling rates have increased (Australian Government Productivity Commission, 2006: 31).

Within Australia, due to the potential risk to health and environment from open-dumping landfill, the most recent method of sanitary landfill is used which is achieved by dumping, compacting, and covering with soil (Department of Primary Industries, Water and Environment, 2004). Modern sanitary landfills are subjected to strict control, where they operate according to the highest environmental standards, in respect of waste reception, control and management (Ramboll, 2007). In addition, they also incorporate features, such as liners and leachate collection, in order to reduce the emissions of leachate and landfill gases (Australian Government

Productivity Commission, 2006: 68). Indeed, the Environmental Guidelines for Solid Waste Landfills and Industrial Landfilling (EPA NSW, 1996) describe the benchmark procedures for the proper management of solid waste in landfills as follows:

a. Lining and capping. Lining of a landfill bed cell is usually accomplished using an impervious material such as compacted clay and/or artificial liners such as high-density polyethylene. Some authors have estimated the life-span of this lining to be up to a century (Baccini, Henseler, Figi & Belevi, 1987; Christensen, 1989: 20). However, more recently, a report by Van Moorst (1996) indicated that some liners have been found to fail after only several years, possibly due to the environment and soil conditions. Therefore, within Australia, there is a call to extensively investigate the current measures of liners in order to prevent the release of contaminants into the environment in the long term (Scott et al., 2005). Capping involves placing a layer (usually of material similar to the liner) over the filled landfill to minimise the infiltration of rainfall or surface water. The main purpose of the cap is to maintain a 'dry' environment within the cell and prevent the generation of leachate.

b. Layering. Layering involves placing the waste in a series of layers of nominal thickness, covering each layer (daily) with clean soil. Layering improves waste compaction and reduces the problems with odours and vermin and decreases the infiltration of precipitation.

c. Compaction. The primary aim of compaction is to reduce waste volume. Compaction does have an influence on other landfill characteristics such as leachate generation, liquid and gas permeability, and decomposition rate (Scott et al., 2005). Canziani & Cossu (1989 cited in Scott et al., 2005) reported that the extent of compaction can significantly reduce leachate volumes.

d. Leachate recirculation. Leachate recirculation is a technique aimed at encouraging saturation in order to stimulate the degradation processes, leading to more rapid stabilisation of the landfill. Moisture is essential in order for biodegradation of wastes to occur, and rather than relying on intermittent rainfall, leachate circulation is employed to enhance and maintain refuse saturation.

3.3. Solid waste management issues in Australia

As detailed earlier, a waste management hierarchy is utilised within the Australian context. In terms of this waste management hierarchy, the main challenge that faces the governments is how it can convince various stakeholders such as industries and communities to adopt more acceptable waste management practices (O'Gallagher, 1990: 65). In other words, a fine balance of the "stick" approach to legislation and its associated penalties and the "carrot" approach of providing incentives for various stakeholders to regulate themselves must be attained in order to achieve sustainable development and management of solid waste policies and strategies (O'Gallagher, 1990: 65).

Indeed, according to Rasmussen and Vigso (2005, cited in Australian Government Productivity Commission, 2006: 144), the waste management hierarchy is only a simplified list of priorities that favours some waste management options over others, and does not take into account the range of costs and benefits associated with different waste management options. In essence, waste management policies need to take account of the location, circumstance, and the overall cost and benefits to the community, rather than simple adherence to the waste hierarchy (Australian Productivity Commission, 2006: 340). An example to illustrate the above notion is the call by the Bureau of Industry Economics (1993, cited in Commonwealth of Australia, 1994: 109) to develop landfill that takes account of the perception of the community and various social and physical costs such as the value of the landfill, location and type of waste, environmental amenity and contingency costs, the relationship between waste disposal charges and recycling levels, on-site retention of waste and penalties for illegal disposal. Therefore, in order to achieve the best solid waste management outcome for a particular area, good data that are based on robust technical and economic analysis need to be collected in order to achieve asustainable outcome (Scott et al., 2005).

3.4 Australian policy and legislative frameworks for solid waste management

In Australia, as elsewhere, traditionally waste management was concerned with any potential adverse outcomes of putrescible waste on public health (Scott et al., 2005). From the early 1970s, the public has become increasingly concerned with the effects of pollution on the environment, and eventually this concern has extended to the management of solid waste (Australian Government Productivity Commission, 2006: 45).

Environmental policy and legislation is a state responsibility in Australia (Hubick, 1991: 122). In essence, solid waste management is mainly under the jurisdiction of each state in Australia. However, many of the policy responses currently in place in the states have their origin in two key national policy initiatives adopted in 1992: the National Waste Minimisation and Recycling Strategy (NWMRS) and the National Kerbside Recycling Strategy (NKRS) (Australian Government Productivity Commission, 2006: 46).

3.4.1 National Waste Minimisation and Recycling Strategy (NWMRS)

Briefly defined, the goals of the NWMRS are to encourage the ecologically sustainable non-wasteful use of resources; reduce potential hazards to human health and the environment posed by pollution and wastes; and maintain or improve environmental quality (Commonwealth Environment Protection Agency, 1992: 10). In addition, it was also made clear in the NWMRS that governments should only pursue waste-related policies if the policies maximised the net benefits to the community (Australian Government Productivity Commission, 2006: 47). NWMRS set the goals to reduce the amount of waste going to landfill site by 50 per cent by he year 2000 and also provide support for the development of new waste management and environmental technologies (Commonwealth Environment Protection Agency, 1992: 12). Flowing from that, in order to achieve this goal, the roles of extended producer responsibility and product stewardship schemes were emphasised in the

NWMRS (Australian Government Productivity Commission, 2006: 47). These schemes place greater responsibility on producers for recovery or disposal of specific goods. Extended producer responsibility (EPR) involves policies that make producers (at least partially) responsible for waste treatment and/or disposal of their products or goods (Lindhqvist, 2000). The responsibility assigned to producers does not make it necessary to physically take back goods and process or dispose of them, rather, producers could be made responsible for financing such activities by others (Australian Government Productivity Commission, 2006: 260). Within Australia, although some agencies questioned the efficiency of just targeting producers, given that many parties are involved in a product's life cycle, many local governments do favour EPR (Australian Government Productivity Commission, 2006: 260). The most common initiatives practised within Australia are take-back requirements and deposit refunds such as those on beverage containers under the container deposit legislation prescribed in the Environment Protection Act 1993 in South Australia (Environment Protection Authority SA, 1998).

3.4.2 National Kerbside Recycling Strategy (NKRS)

This strategy was developed to complement and advance some of the policy actions outlined in the NWMRS (Australian Government Productivity Commission, 2006: 47). Recycling targets were agreed between local governments and industries for materials such as plastic containers, glass, aluminium and steel cans, newsprint and paper (Australian Government Productivity Commission, 2006: 45). Some of the policies of the NKRS that guided the development of industry action plans and state and local government solid waste management plans are those such as the target that more than 90 percent of urban households should have a regular kerbside recycling collection by June 1994, and at least 60 percent of households with access to kerbside collections should use it at least once a month by June 1993 (Australian Productivity Commission, 2006: 48).

3.4.3 State and Territory Government solid waste management policies and legislations

As alluded to earlier, the NWMRS and NKRS were the guiding policy framework for the states and territories throughout the 1990s and have resulted in most states and territories subsequently introducing new SWM legislation and strategies (Australian Government Productivity Commission, 2006: 60). Key legislation, strategies and governance bodies that are related to both waste minimisation and landfilling for both the New South Wales state government and the Tasmanian state government (by way of comparison) will be illustrated in table 3.1 and table 3.2, respectively.

Table 3.1: Key legislation and selected waste minimisation strategies for the New South Wales and the Tasmanian Government, a case of comparison (adopted from Australian Government Productivity Commission, 2006: 51).

	New South Wales	**Tasmania**
Waste minimisation strategies	• Waste Avoidance and Resource Recovery Strategy 2003 • Waste Reduction and Purchasing Policy	• Guide to Industrial Waste Management
Legislation	• Protection of the Environment Operations Act 1997 • Waste Avoidance and Resource Recovery Act 2001	• Environmental Management and Pollution Control Act 1994

Table 3.2: Legislation, regulations and guidelines relating to landfill for the governments of New South Wales and Tasmania, a case of comparison (adopted from Australian Government Productivity Commission, 2006: 175).

	New South Wales	**Tasmania**
Acts and regulations	• Protection of the Environment Operations Act 1997 • Protection of the Environment Operations (Waste) Regulation 2005	• Environmental Management and Pollution Control Act 1994 • Environmental Management and Pollution Control (waste management) Regulations 2000
Landfill guidelines	• Environmental impact statement (EIS) guideline: Landfilling 1995 • Environmental guidelines: solid waste landfills 1996	• Landfill sustainability guide 2004
Government authorities	• Department of Environment and Conservation • Department of Planning	• Department of Primary Industries, Water and Environment

3.5 Australian local government and environmental management

Broadly defined, local government in Australia has, principally, a three-fold role: (1) to provide services to local communities, (2) to maintain the instruments of democratic self-government, and (3) to develop community resources (Power, Wettenhall & Halingan, 1981 cited in Chayabutra, 1994). Within this framework, local councils have responsibility for the regulation of land-use and development by providing approximately 128 services that can be divided into public works and services, such as roads, water supply, and sewerage; recreational facilities and

services such as parks; and community facilities and services, such as the removal of solid and liquid waste (Cutts & Osborn, 1989: 10).

3.5.1 Local government and the solid waste management system

As mentioned earlier, in terms of solid waste management, state governments' solid waste management policies mainly stem from the two national frameworks of NWMRS and NKRS. In turn, local governments adopt these solid waste management policies (Commonwealth of Australia, 1994: 209). Specifically, local governments are normally responsible for land-use planning and development approvals within their boundaries, and also responsible for the collection and disposal of municipal solid waste (Australian Government Productivity Commission, 2006: 339), while the monitoring, regulatory and enforcement matters are the responsibility of the State (Commonwealth of Australia, 1994: 212). A generally accepted rule for apportioning responsibilities for providing public services among the different tiers of government, called the subsidiarity principle, is that decisions where the impact is restricted to a local area should be made at the local level (Australian Government Productivity Commission, 2006: 339). If the impact of solid waste management responsibilities goes beyond local government boundaries- for instance, because of scale economies- there is a case for assigning these responsibilities to a higher level of government (Australian Government Productivity Commission, 2006: 400). In essence, although these activities are carried out at a local level, they are not all controlled by local government, with the degree of authority varying from state to state depending on state laws (Chayabutra, 1994).

As a result of these responsibilities, in many instances there is overlap between the responsibilities of state departments and local government, which can result in conflict of interest or ambiguity over the responsibilities (Chayabutra, 1994; Commonwealth of Australia, 1994: 209). In addition, there was a concern over the lack of knowledge of a number of local councils about the solid waste management options and the state policies that they were required to implement (Australian Government Productivity Commission, 2006: 336 Commonwealth of Australia, 1994: 209). For instance, local governments in the Hobart area were required by the

Tasmanian Government to upgrade all sewage treatment plants to secondary treatment by June 1994. This subsequently resulted in pressure on local governments and generated many internal and external problems (Chayabutra, 1994).

3.5.2 Problems in solid waste management faced by local governments

Due to the gap mentioned above, the most common barriers faced by local governments in terms of implementing solid waste management policies (Commonwealth of Australia, 1994: 210) include:

- a multiplicity of state and local approval systems with contradictory requirements;
- lack of financial and physical support by state government resulting in constraints on a market based property development system on which local government income depends; and
- lack of knowledge, resources and skills transfer from state government to local government level resulting in poorly developed policy framework.

Indeed, a survey by the University of New South Wales found that of the local government planners who considered themselves well informed, only one third were aware of State government reports, and less than a quarter were familiar with Commonwealth Government information (Brown, Orr & Smith, 1992: 11). A separate survey by the University of Western Australia, found that most local government staff considered their information sources to be out-of-date and inadequate and obtained their information primarily through informal communication such as personal contacts (Brown et al., 1992: 61).

Due to this inconsistency faced by local governments, the Australian Government Productivity Commission (2006: 396) has called for the Australian Government to play a more active and significant role than it has in the past by:

- *Working with the state governments to develop and implement consistent waste classification systems and databases*- At a minimum, this would help ensure that

more consistent data was collected (which in turn would assist with monitoring and benchmarking performance), and that similar processes would apply from state governments to local governments. This work would lay the foundation for exploring opportunities to achieve further consistency in regulatory standards applying to solid wastes.

- *Refining information, education and awareness programs to help ensure the local government is well informed about waste management issues and policies-* In particular, effort should be directed at addressing the current 'knowledge gap' between state and local governments.
- *Facilitating research into the significant externalities caused by waste disposal-* The Australian Government could provide a central coordinating role in ensuring a more robust analysis of environmental issues is undertaken. There may be scope for this to be done on a collaborative basis, involving the state and local governments and research institutions, such as the CSIRO and the universities.

3.6 Summary

Chapter 3 details SWM in Australia. Specifically, it describes the strategies that are emphasised by the Australian government, solid waste management issues in Australia, followed by the policy and legislative frameworks that are related to solid waste management in Australia. Lastly, it examises the role state and local governments have in SWM in Australia, and the most common problems faced by local governments in dealing with SWM.

Chapter 4: Solid waste management in Vientiane, Lao PDR

4.1 Solid waste management issues

Waste management is one of the most common and most serious problems in many countries, especially in the least developed countries, and Laos is grouped in that category. The main concern currently is the problem of large volumes of waste in Lao PDR. While the quantities of waste being produced each day increase, Laos still does not have a proper SWM system incorporating waste collection, recycling, and disposal services. In addition, the majority of Lao people do not truly understand the potential risks associated with poor waste management systems (Khanah & Souksavath, 2005). Even though there are a number of projects designed to improve the SWM system in Vientiane as well as in other towns around the country, SWM in Laos still has a long way to go in order to achieve the object of sustainable development. These issues are discussed in greater detail below.

Waste generation in Vientiane Municipality

According to the WHO (2005) in 2001, approximately 91,250 tons of solid waste was generated in the Vientiane Municipality. This equates to solid waste production on average of 0.75 kg per person per day with a daily total estimate of 250 tons (WHO, 2005). Of this estimate, only 80 – 100 tons are collected and disposed of at the municipal landfill site (ADB, 2003). In general, solid waste consists of approximately 30 per cent organic matter, 30 per cent plastic, 15 per cent paper, and 25 per cent glass, cans, and other metals (STEA, 2000 cited in UNEP, 2001 & WHO, 2005). Hazardous and toxic wastes, however, are often mixed with municipal wastes, and no segregation is required (WHO, 2005). With the average per capita waste production changing gradually the population increase becomes the principal source of additional pressure on municipal waste management in Laos (STEA & UNEP, 2006).

SWM system

Waste collection services in Laos are limited to geographically accessible areas, markets, and economically profitable groups, such as high-income residents (STEA & UNEP, 2006). Waste collection does not occur in many remote areas. The result has been that a number of residents still resort to burning and dumping their waste. Waste collection services cannot cover many areas due to lack of financial resources. For example, the fees are too low to compensate government and private contractors for the cost of municipality solid waste collection and disposal (Khanah & Souksavath, 2005). Secondly, most residents are reluctant to pay the monthly waste collection fees (partly because of the insufficient service provided to them). In addition, insufficient and poor maintenance of equipment, and inadequate staffing makes providing SWM services problematic (Khanah & Souksavath, 2005).

The landfill sites in Laos are inadequate and do not meet international environmental standards (STEA & UNEP, 2006). While there are only five landfills in the whole country, only Vientiane and another town (Luangprabang) have barely sufficient separation of hazardous waste from the rest (STEA & UNEP, 2006). However, landfill in Vientiane is still being poorly managed in terms of effectively protecting the environment and health of the surrounding communities (ESL, 2004a). Landfill sites, such as the old Vientiane landfill, "Km 18"[2], are not regularly covered with soil, have no leachate control, the site is surrounded by agricultural land, and it was accessible to scavengers and animal (World Bank, 2005). During the rainy season (July to October), the landfill operations are subject to significant seasonal fluctuations, with the quantities and weight of solid waste rising substantially, as it is too wet to burn waste easily (STEA & UNEP, 2006).

Low public awareness

The factors that contribute to the underdevelopment of SWM are: (i) lack of concern among communities as to the importance of environmental impacts; (ii) lack of motivation to reduce waste generation; and (iii) peoples' unwillingness to separate their waste making it difficult to recycle (Khotsay & Vilaythong, 2005). According to Furedy (1993), because solid wastes in Asian cities normally comprise 70 to 80 per cent organic material including dirt and dust, composting has long been

[2] Called Km 18 because it is located 18 kms from the city of Vientiane. The new site is called Km 36 because it is 36 km from the city

considered the main technique to reduce waste quantities for municipal disposal. Khotsay and Vilaythong (2005) also mention that in some poor areas in Vientiane, there is virtually no support for resident's community managed practices had to dealing with solid waste. In other words, the environmental conditions in these areas are affected badly by the lack of waste collection from households (Khotsay & Vilaythong, 2005). In addition, the on-going practices by local householders of burning mixed waste, particularly plastic and rubber, in the backyard contributes to a serious air pollution problem in urban areas (Khotsay & Vilaythong, 2005).

4.2 Legislative framework

Lao PDR has developed a number of policies, laws, and regulations relevant to environmental protection, energy, forestry, and foreign investments. However, there are currently no specific waste management regulations (Khanal & Souksavath, 2005). While the SWM legislative framework crosses a number of government sectors, including environment, human health and urban infrastructure, it is one of the difficulties in progressing SWM regulation that it is typically defined as a uni-sectoral issue (ESL, 2004a). Because of this overlap, in many instances it is difficult to establish which agency will take the lead role, particularly in countries that are under-resourced in terms of their institutional capacity to create coherent environmental policy (ESL, 2004a).

In 1990, the legal framework for SWM was recognised as deficient in that there was no national waste management legislation, although the Ministry of Health had prepared a Draft Guideline for health and hygiene, which included a chapter on SWM (ESL, 2004a). After the 1992 Rio Earth Summit, Lao PDR established the Science, Technology and Environment Organisation (STENO) directly under the Prime Minister's Office (Khanah & Souksavath, 2005). Within STENO, the Department of Environment (DOE) is delegated the specific task of environmental management (Khanah & Souksavath, 2005). Within this framework, the authority to manage solid waste lies with STENO at the national level, and with environmental management and monitoring units at the ministerial, provincial, special zone, municipal, district and village levels (Khanah & Souksavath, 2005). On the other hand, the Science Technology and Environment Agency (STEA) is responsible for the development of a legislative and regulatory framework for the environment

(ESL, 2004a). As a result, it is difficult to coordinate the roles between the two agencies concerning SWM policy (Foppes, Teerawatsakul & Vest, 2001, cited in ESL, 2004a). Therefore, while progress has been made, specific SWM legislation has not yet been established (Khotsay & Vilaythong, 2005).

The legislative frameworks dealing with SWM in Laos are outlined below:

- The Environment Protection Law of Lao PDR 1998;
- Draft National Health Regulation 2001;
- Guidelines for Hospital Waste Management 1997.
- Industrial Waste Discharge Regulation 1994;
- Provincial Decree for SWM in Vientiane 1999;
- Regulation on the Monitoring and Control of Waste Discharge 1998;
- Decree on the Management of Solid waste and the Cleaning of Public and Residential Areas.

As mentioned earlier, there is no specific waste management regulation. The Lao government has operated with unclear policy on waste management and operational guidelines. For instance, the Provincial Decree for SWM in Vientiane (1999) provides the ability to fine the community littering or dumping waste. However, the decree emphasises only road cleanliness instead of SWM practices (ESL, 2004a). In addition, the Environment Protection Law (1999) is the principal legislation in Laos, but references specifically to waste management are included only in chapter 3, Article 23 *Prevention Measures and Pollution Control* (STEA & UNEP, 2006), "... All kinds of littering are forbidden. It is required to allocate waste disposal sites, and to separate waste before its disposal. Technologies for waste treatment, recycling of waste into production, and reuse must be supported. It is forbidden to import, transport, and move any kind of hazardous waste through land, water and sky border of the Lao PDR."

In short, the lack of law and legislation that deals directly with SWM poses many problems for the Lao Government. According to STEA & World Bank (2005), having different ministries responsible for the development of sectoral legislation results in inconsistencies of legislation. Principle inconsistencies include conflict provision, overlapping commands given to different ministries, poor implementing of

regulations and supporting environmental standards (STEA & World Bank, 2005). Arguing along a similar line, Khanal & Souksavath (2005) contend that the fundamental flaw of the over-arching legislation above, is its lack of effective monitoring, data generation and enforcement that are usually required for SWM to function effectively. The same authors also argue that this over-arching legislation undervalues the need for strong and efficient administration that is required to implement better pollution standards and monitoring guidelines for the practices of SWM (Khanal & Souksavath, 2005). In addition, this over-arching legislation also undermines the need for more sophisticated regulatory compliance staff and better functioning administrative and political institutions (Khanal & Souksavath, 2005). This can be illustrated by the example provided by the Japan International Cooperation Agency (JICA) (1999). In that report, it was noted that the management of solid waste in Vientiane rested poorly under the responsibility of the Department of Communications, Transport, Post, and Construction (DCTPC). This department was entrusted to collect waste from public institutions, hospitals and commercial enterprises (JICA, 1999). This department further delegates its responsibilities to private companies for waste collection (JICA, 1999). The Japan International Cooperation Agency (1999) noted that without proper functioning administrative and political institutions, this has resulted in a collection rate of 13 per cent (in 1999) in residential areas and 22 per cent (1999) in commercial and business areas. As a result, the majority of the uncollected waste is illegally dumped into rivers, drainage or vacant lots in the city (Japan Cooperation Agency, 1999).

In addition, the lack of strong institutional structures with a strong legislative framework has resulted in market-based incentives for SWM becoming predominant in Laos (Khanal & Souksavath, 2005). The market-based incentives aim at internalising environmental externalities by settling costs and benefits to influence decisions and behaviours towards more environmentally desirable situations (Australian Productivity Commission, 2006: 221). However, some scholars question the validity of these initiatives, arguing that they allow people to 'pay to pollute' since every household and commercial institution may generate any amount of waste and then pay the charge (Khanal & Souksavath, 2005). Indeed, the same authors argue that heavy reliance on these incentives for SWM in Laos does not change public attitudes and behaviours towards minimising waste. Without strong legislative

framework, these incentives do not work effectively alone in the management of solid waste (Khanal & Souksavath, 2005).

As a result of this weak legislative framework, Earth Systems Lao, an environmental consultancy company in Lao, has proposed that a round table forum between relevant ministries to assess the current status of laws and review roles and responsibilities, is an essential first step in determining an effective pathway to implementing national waste management (ESL, 2004a).

4.3 SWM initiatives and organisational involvements

So far only three big projects have supported SWM in Laos as outlined below:

The first one is JICA which has been involved in SWM in Vientiane through a number of studies since 1991 (ESL, 2004a). JICA provided the Ministry of Communications, Transport, Post, and Construction (MCTPC) financial support for SWM and it has also been working in coordination with the municipality and the Urban Cleansing Service (UCS) (Khanah & Souksavath, 2005). In addition, JICA helped to establish the collection system, landfill design, disposal techniques, maintenance, purchase of waste collection vehicles, and metal solid waste bins (ESL, 2004a; and MacDonald, 2004). According to UNDP (2001, cited in Khanah & Souksavath, 2005), the JICA project "*Improvement of the Solid Waste Management System in Vientiane Urban Area*" provided heavy equipment and a maintenance workshop to improve the Km 18 waste disposal landfill site (the old landfill), and also provided safe drinking water to residents that live around the dumpsite.

Apart from JICA, the United Nations Development Programme (UNDP) is another sector involved in waste management activities in Vientiane. UNDP tends to focus more on raising public awareness, poverty reduction and income generation from waste materials such as using food scraps for making natural fertiliser and selling recyclables for extra income. According to ESL (2004b), the UNDP's Public Private Partnerships for the Urban Environment (PPPUE) funded project, *"Integrated Solid Waste Management in Vientiane Municipality"*, during 2002 and

2003, had an objective to establish an effective community based system for SWM in Vientiane. The project basically aims to:

- "improve the urban environment by developing and implementing the model for waste management in urban area in Lao PDR,
- improve income generating activities for urban poor through the establishment of small scale enterprises for the collection, separation, and recycling of waste" (ESL, 2004b)

In addition, in 2004, the project continued an external Mid Term Review (MTR) by examining the project's outcomes performance, and identifying problems and suggesting improvements for effectiveness, operational efficiency and management (ESL, 2004b).

While UNDP was working on public awareness, the VUDAA requested the Asian Development Bank (ADB) for finance through the Japan Fund for Poverty Reduction (JFPR) for support to help the government prepare an innovative environmental improvement project for the low-income areas as well as generate income for the poor households in Vientiane Municipality (ADB, 2003). This project is titled "*Solid Waste Management and Income Generation for Vientiane's Poor*". The proposals for this project focus on (i) solid waste collection practices, transportation and disposal services in poor communities; (ii) the capability to plan and implement sustainable community-based SWM and (iii) generating profits and supporting employment opportunities for waste pickers and poor residents (ADB, 2003). According to ESL (2004a), this project has the potential to join with the UNDP project in order to increase the scope and expand its benefits. In addition, this project gives UCS an opportunity to develop a creative and affordable model for a waste collection service in cooperation with communities (ESL, 2004a). There is another project that is based on an ADB loan to VUDAA which is the "*Vientiane Urban Infrastructure and Services*" project and this was implemented from March of 2002 to August 2007 (ADB, 2008). The overall aims of this project are to (i) improve the quality of life of urban residents of Vientiane; and to (ii) enhance productivity and economic growth (ADB, 2008). This project covered only four main districts in Vientiane which are Chanthabury, Saysetha, Sisattanak, and Sikhottabong. The sectors that were covered by the project are drainage, roads, traffic management and

road safety, sanitation, and SWM. In addition, the construction of VUDAA building was also included in the project investment (ADB, 2008).

Apart from these three organisations, there are also some other initiatives that have led to a number of activities in order to improve the waste management system in Laos:

- A grant from the French Government for urban development in 1996 (a grant roughly US$ 2.7 million) (ESL, 2004a);
- A Canadian grant for distribution of waste management and environmental protection booklets (UCSC, 1999);
- The UCS established three workshops that focused on the improvement of handling and disposal of medical wastes (ESL, 2004a);
- A collaboration of the Lao government and a non-government organisation (NGO) which established the *Keep Vientiane Clean* project with funding from the Royal Netherlands Embassy (ESL, 2004a & PADETC, 2008). There are various parties in this project such as VUDAA, the Science Technology and Environment office (STEO), the Participatory Development Training Centre (PADETC)[3], village authorities, recycle traders, the Lao Women's Union, the National University of Laos (NUOL), and schools (ESL, 2004a). This project aimed to improve urban waste management focussing on educational and training programs for all stakeholders (communities and schools). In addition, this project set up a private waste recycling centre, the Lao Chareon Recycling Centre, and promoted recycling banks in schools and villages (ESL, 2004a & PADETC, 2008);
- The ministry of Public Health and the World Health Organisation are constantly promoting the treatment of hazardous and infectious waste in municipality projects (Khanah & Souksavath, 2005).
- A program called "Waste-Econ" run by the Department of Geography and the Institute for Environmental Studies at the University of Toronto, and a number of government institutions, universities, and non-governmental organisations based

[3] PADETC is the private non-profit Lao institution. It provides waste management programs which focuses on Lao communities, especially young people.

in Laos, Cambodia and Vietnam, joined with the National Science Council (NSC) at the Prime Minister's Office in Vientiane to conduct research on waste economy (Waste Econ, 2008). This was a six-year program (2000–2005) which focused on the benefits to the economy and this included recycling, exchanging, and reducing waste (Waste Econ, 2008). According to ESL (2004a), the program delivered training programs; for instance, a workshop in Vientiane. In addition, a pilot project was carried out researching the possibility of using organic waste from markets in Vientiane (MacDonald, 2004).

4.4 Solid waste management in Vientiane

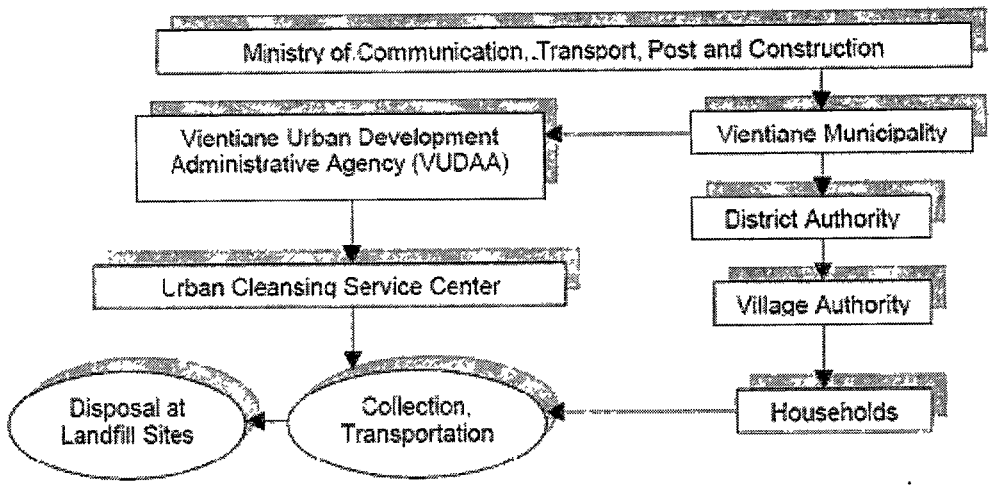
4.4.1 Responsibilities for SWM

Even though Vientiane is the centre for the country's economic, educational, industrial, and business activities, it is faced with a number of environmental problems in general and specifically with solid waste problems (Khanah & Souksavath, 2005). At the national level, the MCTPC is responsible for urban SWM (STEA & UNEP, 2006). The provincial office of the DCTPC controls SWM at the provincial level (UNEP, 2001); for instance, the Vientiane Municipality level. The responsibility for SWM infrastructure and services in Laos depends on the district authorities and, for Vientiane Municipality, lies with the Vientiane Urban Development Administrative Agency (VUDAA)[4] (ESL, 2004a). At the district level, there are village authorities and residents respectively. Figure 3 shows an outline of the responsibilities of each organisation. The Urban Cleansing Service (UCS) is the main authority that has been dealing with SWM in Vientiane since 1998 (Khanah & Souksavath, 2005). It was established under the VUDAA and it provides cleansing services, waste collection, transportation, and disposal for most residential, institutional, and commercial sectors around Vientiane Municipality.

In addition, the Ministry of Public Health (MoH) is responsible particularly for hospital and health sector waste and the Ministry of Industry and Handicraft (MIH) is responsible for industrial waste management (STEA & UNEP, 2006).

[4] VUDAA - a division that is responsible for urban services, planning, infrastructure, environment and sanitation in Vientiane.

Figure 4.1: Organisational structure of SWM in Vientiane Municipality



Source: VUDAA cited in Khanah & Souksavath (2005)

The Lao government is gradually expanding a central SWM programme from the larger to smaller cities (STEA, 2000 cited in UNEP, 2001). As in the National Environmental Action Plan, SWM is an on-going subject of priority (STEA, 2000 cited ESL, 2004a). Thus, every central SWM has to be based on the following strategy (UNEP, 2001 & ESL, 2004a):

- full waste collection coverage of all urban areas;
- promotion of a gradual expansion of a SWM program;
- full fee payment system for waste collection and disposal, and payment for households depending on level of service;
- improvement of disposal sites in order to protect ground waste, air quality, and amenity;
- a minimum investment in mechanical equipment;
- emphasis on organisation and community mobilisation to assist in SWM; and
- cutting down the amount of waste by encouraging both waste reduction at source and micro-enterprises to use resources within the waste stream.

4.4.2 Waste disposal and landfill site

In terms of waste management, it is obviously of concern that the majority of Lao people who still either burn or dump in low-lying plots or water bodies (STEA & UNEP, 2006 and MacDonald, 2004). Hazardous and toxic wastes, for example, batteries, paint cans, aerosols and other unused wastes, are usually mixed with organic material, plastic, paper, glass, and other metals (World Bank, 2005). This mixture of wastes can clearly be seen at the landfill. However, unwanted large materials such as fridges, washing machines, and furniture are traditionally given away to someone else or sold to the shops in order to be reused. Hence, this component of the waste management stream is not as problematic as it is in developed countries (Becklake, 1991: 6).

Because of the small disposal areas, there are still no leachate collection or monitor wells (World Bank, 2005). Household waste remains of concern around the country. According to ESL (2004a), over the last decades, economic development has brought about growing incomes and greater access to consumer goods. Because traditional consumption patterns have changed and the waste stream composition also has changed with a growth in plastics and a related decrease in organic materials, traditional methods of waste disposal are no longer appropriate (ESL, 2004a).

Currently, there is a new dumping site located at 36 kilometres southeast of Vientiane city. This landfill site opened in 2007 after the km 18 landfill was full (the next chapter describes the capacity of the Km 36 landfill). Even though the landfill at km 18 was actually constructed for a fifteen year lifespan and had a maximum capacity of 900,000 tons to be reached in 2010 (MacDonald, 2004), it has been closed for dumping rubbish and it is planned to develop the site as a golf course. According to Toowoomba Regional Council (2008), it is common to use full landfills as community sites, for instance, parks, sports areas, wildlife habitats, and golf courses. However, there are various considerations such as time and effort for replanting trees and shrubs due to low nutrient content, heavily compacted soils and the production of methane (Toowoomba Regional Council, 2008). In the case of Km 18 landfill site, there are risks which need to be considered with this golf course development which include land submergence if the landfill decays and it has not been compacted properly and the production of methane gas.

Originally, the old landfill site at Km 18 aimed to improve the development and management of the landfill from an open dump landfill, to a sanitary site, and finally to improve sanitary landfill with technical and financial supported from JICA (ESL, 2004a). However, the Km 18 only operated as sanitary landfill, between 1998 and 2000 since which the landfill site slowly reverted back to an open dump landfill (ESL, 2004a). This obviously showed all the problems associated with this mode of operation (ESL, 2004a). The table below shows the main features of these levels of landfill which were considered to be a part of the Km 18 landfill development.

Table 4.1: Main features of the levels of landfill and leachate control

Level	**Main physical & operational features**	**Leachate treatment & containment**
Open dump	Open dump contained within designated perimeter, rudimentary internal roads, no weighbridge, no leachate collection facility	No capacity to prevent rainwater entering landfill body, no collection or treatment of resulting leachate
Sanitary landfill	Daily compacting and covering of all incoming wastes. Storm water drains, weighbridge, gatehouse facilities, perimeter fencing, improved access roads and leachate collection but not treatment	Covering of waste reduces water entering landfill body; separation of stormwater from leachate may be collected in leachate pond but is untreated and may permeate into the ground.
Improved sanitary landfill	Daily compaction and covering of all incoming wastes. Storm water drains, perimeter fencing, all weather access roads, leachate collection and treatment	Covering of waste reduces waste entering landfill body; separation of stormwater from leachate is collected in leachate pond and is reticulated back into the landfill preventing discharge to the surrounding environment.

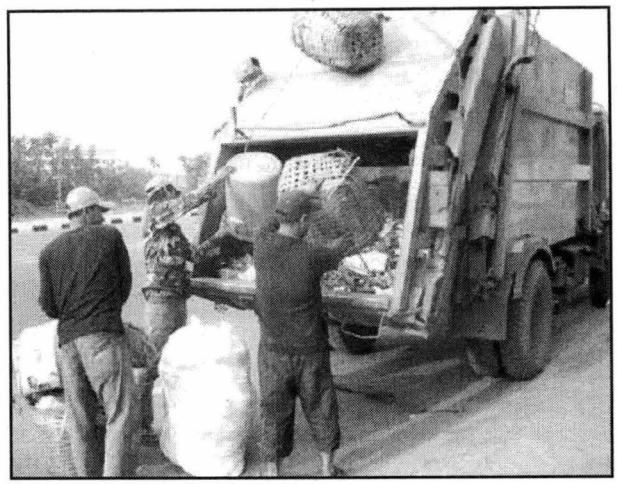
(Source: JICA, 1996; cited in ESL, 2004a)

Today, impacts from landfill are a major concern worldwide. The installation of gas controlled technologies seems to be quite common, especially in developed countries. According to the Agency for Toxic Substances and Disease Registry (ATSDR) (2001), a landfill may require gas control measures for a number of reasons such as government regulations, odour problems, or uncontrolled releases of gases that might pose safety and health concerns. ATSDR (2001) also states that governments have developed laws and regulations in order to trim down health and environmental impacts from landfill gas emission through the reduction of ozone precursor (volatile organic compounds and nitrogen oxides), methane, non-methane organic compounds (NMOCs), and odorous compounds. In the case of Laos, however, there is no regulatory requirement from the government and it is still a long way away from the implemention of landfill gas control. According to Tanthachoon, Chiemchaisri, Chiemchaisri, Tudsi, & Kumar (2008), the gases produced from biodegradation of solid waste in landfills, are released directly to the atmosphere without any treatment. The major landfill gases that contribute to ambient temperature increasing are methane and carbon dioxide which result in the "greenhouse gas effect".

4.4.3 Waste collection systems

Recently, several private companies have joined USC to handle the whole city waste issue. Thus, a combination of state and private companies have been allocated different sections of the urban areas to take up the task of waste collection (UNEP, 2001). Figure 4 gives a good example of waste collection service activity in the city centre of Vientiane. It illustrates the type of vehicles (close-type compactor) that the service uses for the normal waste collection, types of bins used by residents, and the waste collector.

Figure 4.2: Waste collection service in Vientiane



Source: ESL (2004a)

As mentioned earlier, waste collection services are limited to accessible areas. Full waste management services are provided in only the four districts of Chanthaboury, Sikhottabong, Sisattanak and Xaysettha Districts. In these areas, the municipality government dictates collection regularity and any associated costs are paid by households (UNEP, 2001).

Domestic and commercial waste normally has the same composition. Government agencies or private companies have the responsibility to collect from the premises or place rubbish bins along main roads (UNEP, 2001). According to Khanah & Souksavath (2005), bamboo bins and polyethylene bags are still commonly used to store rubbish in household areas, and waste collection points in market and office areas. There are fifty large containers installed around the city to collect large quantities and those containers are returned once the contents have been deposited in the landfill site (Khanah & Souksavath, 2005).

4.4.4 Waste Recycling

As mentioned above, the government, local NGOs, UNDP and PADETC established Lao Chareon Recycling Centre. This is one of the biggest recycling centres in Vientiane which provides training for communities on how to deal with recyclable waste and how to generate their income from those materials. Apart from the Lao Chareon Recycling Centre, there is another private collection recyclables centre which is located 7 km from the city centre. Staff at these centres obtained

training at the Wongpanit Recycling Company (a Thai company) and also received follow-up and support from PADETC (Khanah & Souksavath, 2005). In addition, this recycling centre mainly buys recyclable wastes and exports them to neighbouring countries such as Thailand or Vietnam.

The Lao Chareon Recycling Centre has promoted the development of recycling banks which buy or collect recyclable materials from individuals around the city area, members of the informal sector (waste pickers and scavengers at the landfills), communities and schools (Manivong, 2004 cited in MacDonald, 2004). There are now around thirty recycling banks that operate in Vientiane and these include twenty in communities and ten in schools (Khanah & Souksavath, 2005). A number of recycling banks were funded by the Royal Dutch Embassy and the German donor GTZ[5] (ESL, 2004b). In addition, these recycling banks were created to receive recyclable waste from households that had been trained to separate the organic and residual household wastes from the recyclable materials (ESL, 2004b). According to Khanah & Souksavath (2005), most students and teachers in the schools are operating and managing the banks as an additional curricular activity. Once the banks are full, they normally contact the recycling centre and then sell their wastes (Khanah & Souksavath, 2005). The pricing system for waste purchase depends on the different waste categories that communities bring to deposit in the recycling banks (PADETC, 2008). In order to reduce the volume of wastes that goes to the landfill, recycling activities are being encouraged for all communities in Vientiane Municipality as well as the whole country. Laos has applied a deposit – refund system for most recyclable materials such as bottles, cardboard, plastics, and papers. This system is basically like a tax on the purchase of a product with subsidy for returning the used item to a designated collection site (NCEE, 2001). The idea of the refund system is to encourage individuals and firms to dispose of those used items in an environmentally acceptable method (NCEE, 2001). Thus, this is the most effective way to encourage people to return the recyclable products. In Vientiane, most of the drink bottles are traditionally returned back to the shop. In particular for beer bottles, a deposit of 1000 kip (US$ 0.10) is required (Khanah & Souksavath, 2005). In addition, some households donate the recycling materials such as glass and plastic bottles and car batteries to waste dealers and pickers, and most of the broken

[5] GTZ (Gesellschaft für Technische Zusammenarbeit) is an international cooperation enterprise for sustainable development.

glass collected by the scavengers normally is sold to the recycling centres in the closest areas (Khanah & Souksavath, 2005).

4.4.5 Waste pickers

In Asian cities, there are extensive waste economies that are based on the activities of itinerant waste buyers, waste pickers, small waste shops, tip shops, dealers, transporters, and a wide rang of recycling industries (Furedy, 1993). Today, more people resort to waste picking as a survival strategy (Furedy, 1993). In Vientiane, approximately 300 waste pickers are currently working in the city and about half of them have been registered (Khanah & Souksavath, 2005). Around 200 waste pickers work at the landfill site and the rest are working in the city (Khanah & Souksavath, 2005). Figure 4.3 shows the waste pickers at the Vientiane landfill site. This is a good example showing how the waste pickers work in precarious working conditions. In general, waste pickers recover materials to sell for reuse or recycling, and divert the materials for their own consumption (Madina, 2005). According to Khanah & Souksavath (2005), most private waste contractors and the recycling centres such as the Lao Chareon Recycling centre, usually buy recyclable wastes from the waste pickers at the landfill site.

Figure 4.3: Waste pickers in Vientiane

(Source: Waste-econ, 2000)

Waste pickers are in contact with waste everyday. They are often associated with dirt, disease, squalor, and perceived as a nuisance, a symbol of backwardness and even as criminals (Medina, 2005). As mentioned above, the *"Solid Waste Management and Income Generation for Vientiane's Poor"* project was supported to improve the municipal landfill conditions (the old landfill at Km18). It established a waste pickers' multipurpose centre (WMC) which provides a training and reference center for waste pickers and residents to increase income, promote work safety amongst waste pickers and workers at the landfill, and improve management capability of the municipal landfill authority (ADB, 2003).

4.5 Summary

This chapter describes the waste management practices and issues associated with solid waste management in Laos. In general, the main concern in regards to solid waste in Vientiane, is the increase in the waste volume, the poor SWM system, and low public awareness. Furthermore, this chapter also describes the legislative framework relating to the management of solid waste in Lao followed by the organisations involved. Specifically, this chapter focuses on SWM in Vientiane which includes the responsibilities for SWM, waste disposal and landfill site, waste collection service, waste recycling, and waste pickers in Laos.

Chapter 5: A survey of solid waste management in Vientiane

5.1 Purposes of the survey

This chapter by way of a survey the status of SWM activities in Vientiane Municipality, Lao PDR. The main purpose of this survey is to identify gaps and potential improvements for SWM in Vientiane Municipality. Therefore, the focus is on the quality of solid waste services and the perspectives of the community towards their waste services. In addition, it explores householders' behaviours, for instance, the way that householders dispose of their waste. Lastly, opinions on how to improve waste services for both residents and service providers are highlighted.

Basically, the survey focuses on the stakeholders that are involved in the SWM. This includes three main players: (i). the government, (ii). the private sector, and (iii). residents. This chapter describes SWM of both government and the private sector, and also examines the roles of those two sectors in terms of waste collection and disposal practices. The government in this context is the VUDAA, which is the main agency responsible for Vientiane's infrastructure and services. In 1998, VUDAA formed the UCS as a component of urban infrastructure and services (collection, transportation, and disposal), and as a dedicated SWM institution within VUDAA (ESL, 2004a).

There is also a number of private waste companies that are involved in managing SWM in Vientiane. The majority of them provide waste collection services for a number of industries, institutions, and households. Hence, it is important to involve some of those private companies in this study. Two private waste contractors were selected. Chanthabury Cleansing Company, and Lao Garbage Company. It is important to obtain information about how they organise and manage their services to the public in order to understand their operations, the drivers and impediments to improving waste management.

As mentioned in chapter one, for logistical reasons, two districts in the rural area were excluded. Since, the government and private sector do not provide services to these two areas, information is difficult to obtain.

The reasons behind the household survey are to understand urban and rural residents' perceptions of waste management and to obtain a comprehensive overview of SWM in urban versus rural areas. Subsequently, this allows for acquiring information on management practices and associated problems in these respective areas.

In essence, this survey solicits opinions or feedback from the three groups of players to enable identification of opportunities, weaknesses, and hurdles. The outcome component of the survey comprises quantitative analysis. Quantitative analyses include secondary data analysis and the stakeholder survey. The secondary data analysis includes measurement and analysis of existing reports and literature that are related to SWM in Vientiane Municipality. The stakeholder survey solicited stakeholders' opinions, the current situation of SWM practices, systems, and waste management services in order to suggest ways to rectify the problems that those stakeholders still face.

It needs to be noted that the term "village" has two connotations in Laos. In rural areas, a village is a discrete entity areas but in urban areas villages flow into and about one another. The term village is used in reference to the level of organisation where a village head is represents the party and responsible for local management.

5.2 Methodology

First, the method for this study was to review all relevant literature that is associated with SWM in Vientiane, Lao PDR. The literature reviewed documentation related to previous and current waste management projects. These documents include articles from web sites, reports and papers obtained from the government and NGOs/international organisations and private companies. Interviews were conducted with three stakeholders: VUDAA (government), two private waste contractors and local residents.

The research methodology consisted of two survey questionnaires. The first was administered to the VUDAA and two private waste providers, and the other to 102 households in both urban and rural areas in Vientiane Municipality. However, the questionnaires for VUDAA and private waste contractors are slightly different from the household questionnaire. The questionnaires for each sector are shown in appendix 1, 2 and 3, pp 103, 109 and 113 accordingly. The questionnaires were translated into Lao. Back translations and successive revision of the two different language versions of the questionnaires were conducted by native language speakers. The interview processes were undertaken by the environmental consultancy company, Earth Systems Laos (ESL) and six people were hired to conduct the household survey. Earth Systems Laos and the six people were contacted via e-mail and telephone communication. All of the subjects had been informed of the process of the survey and invited to participate on a voluntary basis. Both government and the private sector had nominated their respective managers to answer the questionnaires. This is because the managers were the key personnel responsible for waste management services and have a complete overview of the company's operations.

The interview forms for VUDAA and the two private waste contractors were delivered and collected by ESL. The survey process started around the end of May, 2008 and the first questionnaire was returned from Lao Garbage Company within three weeks. The following questionnaire received was the Chanthabury Cleansing Company (within four weeks). VUDAA took more than two months to return the survey questionnaire. According to VUDAA, the reason for this delay was because only one person could answer the questionnaire and that person was not available at that stage.

For the household survey, households were selected on a random basis in the three chosen districts of Chanthabury, Sekhottabong, and Xaithany. Both Chanthabury and Sekhothabong are located in the urban area, and Xaithany is in the rural area. Fifty survey questionnaires were randomly distributed to Chanthabury and Sekhothabong district. Xaythany was allocated 52 survey questionnaires on a random sampling basis. In addition, the urban areas were randomly divided into four villages that are in the city centre (with commercial and businesses) and residential areas

(householders). Households in rural areas were also randomly selected along the main roads and side roads. Every fifth house was selected and alternate road junctions. Table 5.1 indicates the survey areas in both districts and areas, and also the number of households.

Table 5.1: A list of survey areas

Area	District	Village	Number of households
Rural	Xaithany	Xangkhou	16
		Khamhoung	17
		Tanmexay	19
Urban	Chanthabury	Sylom	12
		Sesavate	12
		Hatsadee	12
	Sikhothabong	Sehom	14

The household questionnaire contains questions on the collection, disposal of waste, and the semi-structured interview that allows for participants' opinions on the waste management-related issues. It took around fifteen minutes per household to conduct the survey. Therefore, the six surveyors were employed for one day. ESL contacted and briefed those six staff on the purpose and requirements of the research.

5.3 Survey Results

The following provides the survey results from the VUDAA, two private waste companies, and households respectively. There is also some additional material.

5.3.1 VUDAA and private waste contractors

5.3.1.1 General details and waste collection services

VUDAA

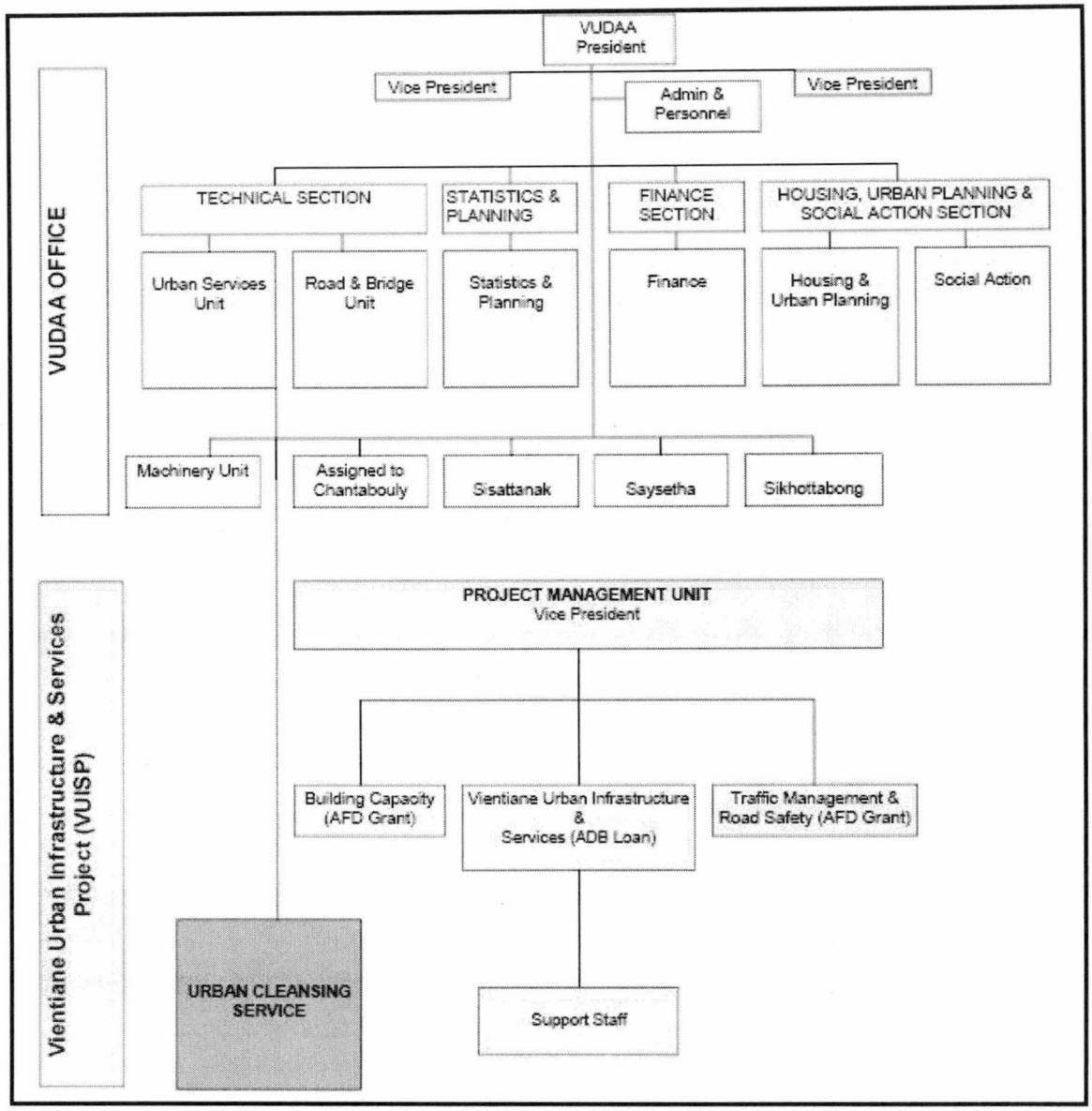
In 1995, VUDAA was established by Vientiane Municipality to handle a wide range of urban development issues in Vientiane. According to ESL (2004a), VUDAA has two major areas of responsibility: (i). the general office which is responsible for on-going activities, and (ii). the project management unit which is responsible for particular projects within the urban development framework. Thus, their responsibilities include planning, operating, managing, and maintaining local government infrastructure services and environmental programs (Khanal & Souksavath, 2005). Figure 5.1 illustrates the VUDAA organisation flow chart in order to understand its structure.

According to VUDAA, since 1998, the quantity of waste collected has grown rapidly. This amount of waste is shown in Table 5.2 below.

Table 5.2: Waste volume collected per annum

Year	Annual Waste volume (Tons)	Daily collection (Tons)
1998	25,981.79	71.18
2000	35,888.82	98.32
2005	46,575.69	127.60
2007	52,948	145

Figure 5.1: VUDAA organisation flow chart



(Source: ESL, 2004a)

Waste collection, disposal, operation, and the management of landfill are the main activities in which VUDAA is engaged in Vientiane Municipality. Currently, VUDAA employs 212 people. The staff includes both administrative staff and those who work in the field. Waste collection vehicles include around 9 hi-tech vehicles, close-type compactors; 33 are open dump trucks, and the detachable container trucks. These trucks are a mix of Japanese vehicles, reconditioned French waste collection vehicles, and locally purchased vehicles (Khanal & Souksavath,

2005). In terms of waste management services, VUDAA mainly provides waste collection and disposal for most domestic households, commercial, institutions, hospitals, and construction sites in the whole city area. Currently, there are approximately 22,819 households in both urban and rural areas that use their collection service. While the urban area includes all four districts (Chantabury, Sikhottabong, Sesattanak, and Saisetha), there are only some parts in rural areas that their service can cover, and these are: Naxaithong, Xaythany, and Hadsaifong. According to VUDAA, residents in the areas in which waste collection services are provided: (i). dispose their waste by burning or dumping in the waterways or vacant land; (ii). take waste to the landfill themselves and (iii). sell their recyclable items to either the pushcart collectors or the shops. In areas covered by VUDAA, the collection service provides a weekly collection from Monday to Saturday on a selected day of the week for each district. However, the VUDAA collects twice a week in some places. This depends on the quantities of waste and geographical area. The charge for household waste collection is normally around 24,000 kip (AUS $ 2.40) per month. Additionally, if the amount of household waste is over the limit, VUDAA charges around 6,000 kip (AUS $ 0.60) per bamboo bin. Waste collection usually occurs between 5am and 5pm on working days.

Apart from household customers, VUDAA also covers approximately 185 private sector customers and 56 institutions. Wastes from these sectors are categorised as large quantities and they are mostly from restaurants, markets, hotels, and other private businesses. In general, commercial waste is collected every night starting at 8pm. Institutional waste is collected 2 to 3 times a week, but in some places only once a week.

Rubbish bins or skip bins are not provided for most sectors. However, where there is a large volume of waste such as commercial or hospital wastes, there are very limited skip bins provided. The charge for commercial businesses, hospitals and construction sites depends on the quantities of waste and also depends on negotiation between VUDAA and customers.

Figure 5.2 below illustrates the waste collection activity in Vientiane Municipality. It shows the waste collectors collecting rubbish bins (bamboo bins) with the open dump truck at the market in the city area. Usually, there are around

five collectors per truck to handle waste collection. Waste collection vehicles parked to collect their waste cause heavy traffic jams.

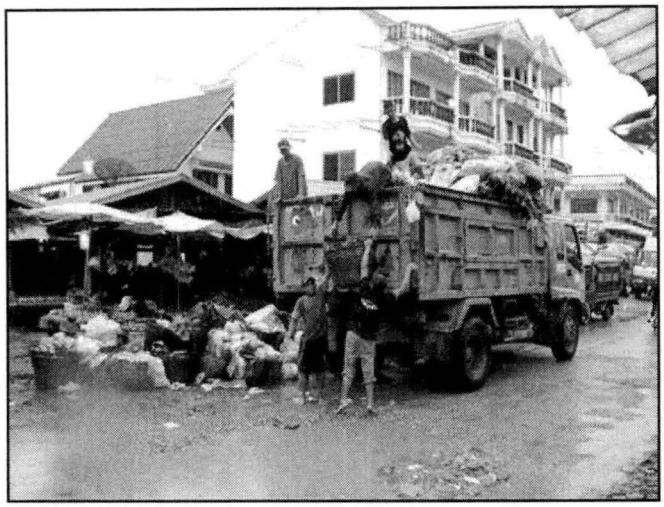


Figure 5.2: Waste collection activity with a large open dump truck at the market in Vientiane
(Source: Waste Econ, 2000)

Based on the information obtained from the VUDAA questionnaire, there are several private contractors involved in providing waste management in Vientiane. These are:

- Waste Transport and Cleansing Service
- Lao Garbage Company
- Chanthabury Cleansing Company
- Municipality Waste Transportation Company
- Transportation Service
- Xaysettha Waste Transportation Centre
- Hadxaifong Cleansing Service Company
- Naxaithong Waste Cleansing Company

The number of private waste contractors has increased over the years. Some of them have equipment provided by NGOs/ non-NGO and different types of vehicles given by donors. However, most of the small private waste contractors were found to be self-funded. All of them are responsible for their designated areas.

Lao Garbage Company

The Lao Garbage company is a private company established in 1995, as a cooperative enterprise between Lao and Thai interests (ESL, 2004a). Currently, Lao Garbage Company employs 92 people in total: about 60 field workers and the rest are administrative staff. The company operates 13 hi-tech trucks and 6 large open dump trucks for waste collection service. The Lao Garbage Company provides the waste collection service for domestic households, commercial companies, institutions and hospital wastes. Although the company does not provide rubbish bins to householders, limited skip bins are provided to some sectors such as commercial companies and institutions. Its commercial contracts include Beer Lao Company, Vientiane Airport, which used UCS (ESL, 2004a). The company has approximately 9,011 households, and 40 commercial customers. The Lao Garbage Company works from Monday to Saturday, from 8am to 6pm. The operating cost of their waste collection service for households is around 18,000 kip (AUS $ 1.80) per month or 4,500 kip (AUS $ 0.45) per bin, and for the commercial sectors roughly 300,000 - 600,000 kip (AUS $30 to $60) per trip. Table 5.3 illustrates the areas and number of villages for which the Lao Garbage Company provides a waste collection service in both urban and rural area. The service basically covers only four districts in both areas. These are: Chanthabury and Sikhottabong, Hadxaifong, and Xaithany. With the number of households from which they collect, the quantity of waste is approximately 2,500 tonnes per month. This equals approximately 80 tonnes per day. Industrial and construction material collected is approximately 448.2 tonnes per month; office waste, 172.6 tonnes; and electronic waste, 59.7 tonnes per month.

Table 5.3: Summary of the weekly designated areas of the Lao Garbage Company waste collection service

Day	District	Number of Villages	Number of households
Monday	Sikhothabong	19	1,958
Tuesday	Chanthabury	8	2,164
	Sikhothabong	2	
Wednesday	Chanthabury	7	1,686
	Sikhothabong	9	
Thursday	Xaithany	20	1,707
	Hadxaifong	7	
	Chanthabury	1	
Friday	Chanthabury	6	1,341
	Xaithany	3	
	Hadxaipong	2	
Saturday	Chanthabury	1	155
Total		**85**	**9,011**

Chanthabury Cleansing Company

Chanthabury Cleansing private contractor is one of the smallest waste collection companies in Vientiane with only 21 employees in total. The company does not have any sub-contract with the government, and it operates a waste collection service with just 3 open dump trucks and another 2 Hyundai vehicles. In general, the company offers their waste collection service to domestic residents and a small number of commercial business, institutions, and schools. As this is a small waste collection company, rubbish bins or skips are not provided. According to ESL (2004a), Chanthabury Cleansing Company is responsible for collecting its own fees and performing its own marketing activities. Their waste collection service fee is a little bit cheaper than other companies, for example, the fee for domestic household waste collection is about 18,000 kip (AUS $ 1.80) per month (same as Lao Garbage Company), according to Chanthbury Cleansing Company. The customers' data base

shows that there are about 2,800 residents and 15 commercial customers. The collection service occurs from Monday to Saturday between 3 am and 6 pm. The collection service covers only the urban area, and this includes Chanthabury, Sisattanak and Sikhottabong. The volume of waste that Chanthabury Cleansing Company collects each year is approximately 5,000 tonnes.

5.3.1.2 Waste disposal and landfill site

VUDAA operates a sanitary landfill site at Km 36 (from the city centre). Km 36 is the main solid waste disposal area in Vientiane Municipality with a total land area of about 750 ha which is a lot bigger than the old landfill. So far, this landfill site has used up to 100 ha with 36,853.57 tonnes (from January to July). This landfill is mainly financed by the Lao Government. In order to gain entrance to the landfill, an entry fee must be paid.

According to VUDAA and the two private waste contractors, most of the waste from households, hospitals, industrial and construction site is generally disposed of at Km 36 landfill. In Vientiane, hazardous wastes are separated from the main disposal area inside the landfill boundary (STEA & UNEP, 2006). Even though medical waste has a designated area at the landfill, toxic and non-toxic wastes are still combined.

According to the VUDAA survey data, the Km 36 landfill is poorly managed, as there is no proper landfill management system. The Lao Garbage Company and Chanthabury Cleansing Company indicated that their main concern is related to the open dump and irregular covered waste, as it produces a bad odour and inundation which is especially problematic during the rainy season.

5.3.1.3 Potential for implementation of waste collection and disposal

➢ *Waste collection service*

Waste collection in Vientiane is limited to accessible areas, because there are a number of problems that the three stakeholders are facing. The important considerations for the three waste collection providers are:

- adequate transport
- adequate staff
- vehicle maintenance
- appropriate landfill
- running costs

In order to improve waste collection services, Chanthabury Cleansing Company suggests that the Lao government should put more effort into public awareness. The main source of waste comes from the community; therefore, everyone should know how to manage their waste in order to improve the waste collection service as well as reducing their waste at the same time. VUDAA and the Lao Garbage Company also suggest that residents should be responsible for their own waste by separating recyclable and general waste. In addition, because both private and municipal collection services still lack financial support, householders should be willing to pay the waste collection fee in order to improve waste collection services.

➢ *Waste disposal*

The current environmental effect of solid waste disposal is mainly pollution. This is a serious concern for people's health; especially those people who work at the landfill (for example, waste pickers). However, respondents said that the Km 36 disposal site requires more financial support, expertise in landfilling management and appropriate equipment. Raising community awareness about the environmental effects also should be a crucial focus. Thus, one of the most effective methods is to

promote public awareness through the media such as television, radio, and internet on how to dispose or reduce the amount of waste

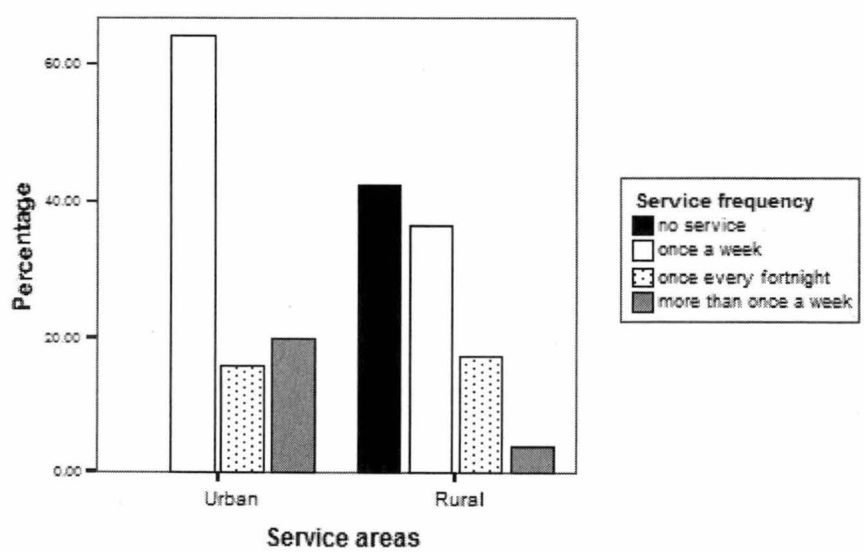
5.3.2 Domestic households

The household survey questionnaire consists of 15 questions. These were divided into four parts: (i). waste collection service, (ii). waste disposal, (iii). the possibility of improving waste disposal, and (iv). the possibility of improving waste disposal and collection service. The following indicates the results of each section by area.

5.3.2.1 Waste collection service

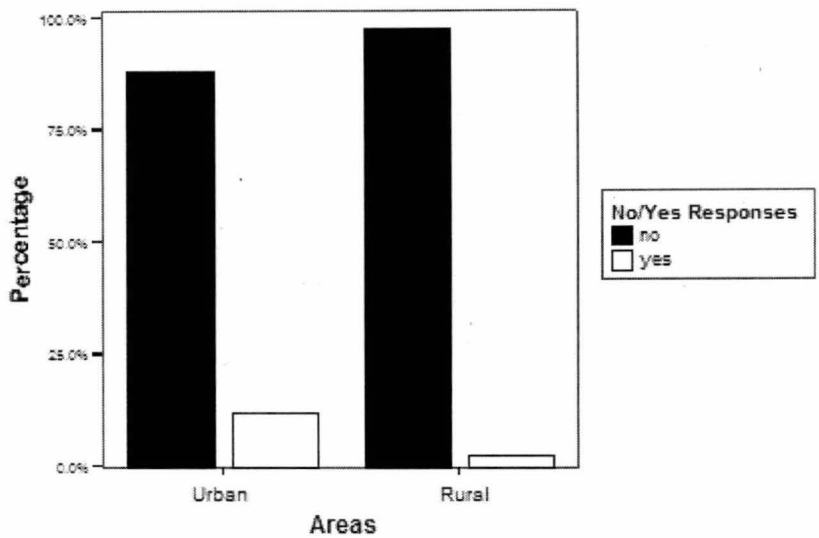
Figure 5.3 indicates that weekly waste collection services are provided to up to 60 per cent of residents in urban areas, 20 per cent of residents receive the service more than once a week, and 16 per cent of them receive a fortnightly service. In contrast, up to 42 per cent of houses in rural areas do not receive any waste collection service, 36 per cent of them receive weekly service, 17 per cent of houses obtain a fortnightly service, and lest than 5 per cent of the households have more than a weekly service.

Figure 5.3: Frequency of waste collection by area



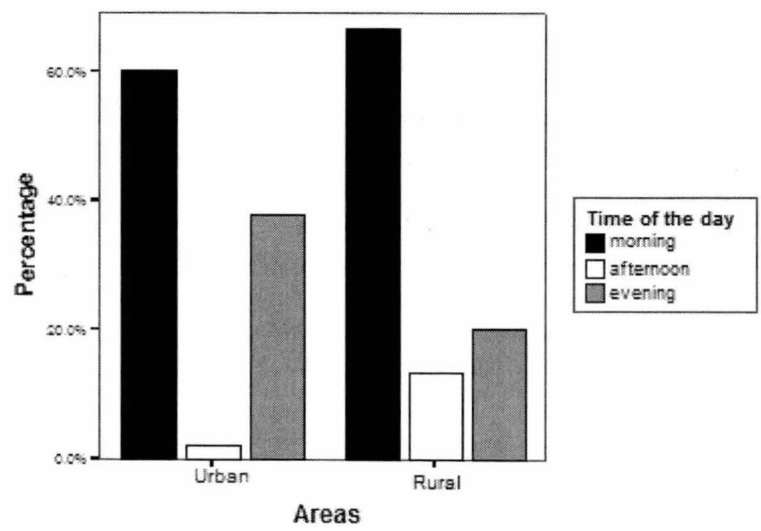
Rubbish bins for residents are not available for either urban or rural areas. Figure 5.4 shows that more than 90 per cent of houses in rural areas and about 88 per cent in urban area are not provided with rubbish bins. However, 12 per cent of households in urban area receive rubbish bins while only 2.5 per cent of households in rural areas received them.

Figure 5.4: Rubbish bins provided by area



As can be seen in figure 5.5 below, waste collection services usually take place in the morning for both urban and rural areas, followed by evening time collection. However, afternoon waste collection service is more likely to occur in rural areas as opposed to urban areas.

Figure 5.5: Timing of service by area



In urban areas, nearly 60 per cent of households use the VUDAA service, 22 per cent of households do not know which service they currently use, and 20 per cent of households use private waste contractors (figure 5.6). In contrast, it is interesting that around 40 per cent of respondents in rural areas do not receive waste collection service, 32 per cent are using VUDAA, 19 per cent do not really know which service they are using, and around 5 per cent use private contractors' waste collection services.

Figure 5.6: Waste disposal service used for normal waste by area

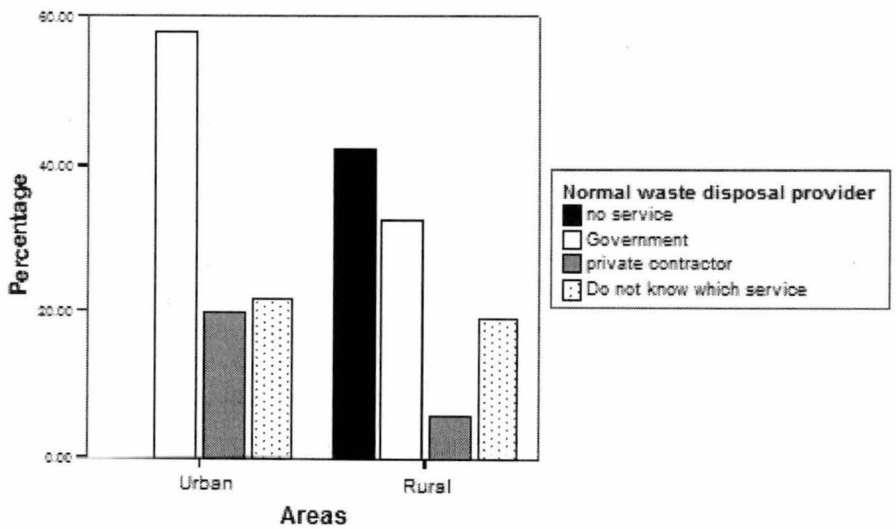


Figure 5.7 shows almost 60 per cent of respondents in both urban and rural areas indicated that waste collection providers never failed to collect their waste. Meanwhile, 40 per cent of respondents in both areas said that on occasions the waste collection services had failed to collect the waste. In addition, 8 per cent of households in the rural areas indicated that they have no idea.

Figure 5.7: Failure to collect waste by area

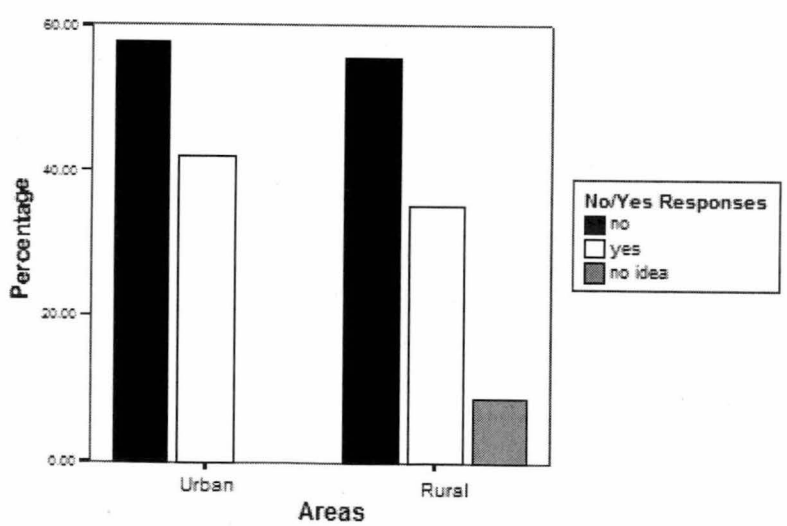
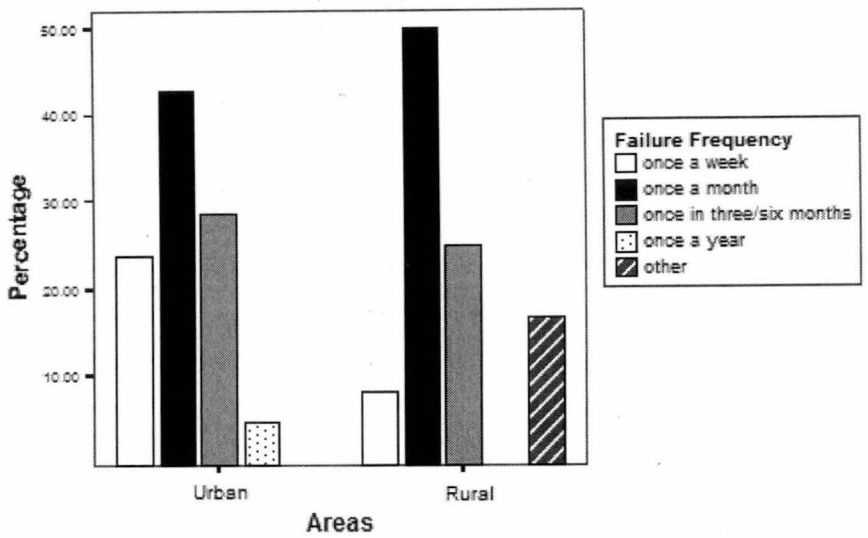


Figure 5.8: Frequency of failure to collect waste by area



The majority of respondents in both urban and rural areas indicated that waste collection services failed to collect waste at least once a month (Figure 5.8). Meanwhile, in urban areas, approximately 25 per cent of the respondents indicated that the waste collection providers failed to turn up at least once a week, as opposed to 8 per cent of respondents in the rural area.

5.3.2.2 Waste disposal

The majority of people in rural areas responded that they never separate their waste. The survey data in figure 5.9 shows that 67 per cent of respondents in rural and 38 per cent in urban areas said they never separate their waste. Approximately 45 per cent of respondents in urban area do separate their waste as opposed to 25 per cent in the rural area. The percentage of residents indicating that they sometimes separate their waste is approximately 15 per cent and 10 per cent for urban and rural areas respectively.

Figure 5.9: Waste separated into different categories by area

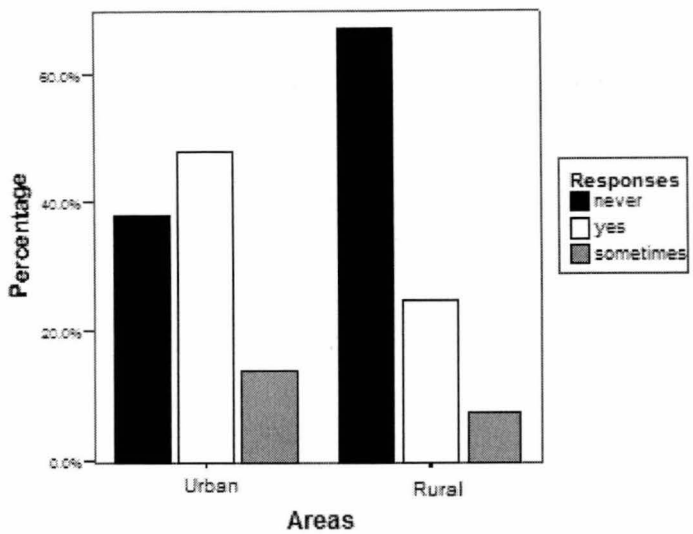
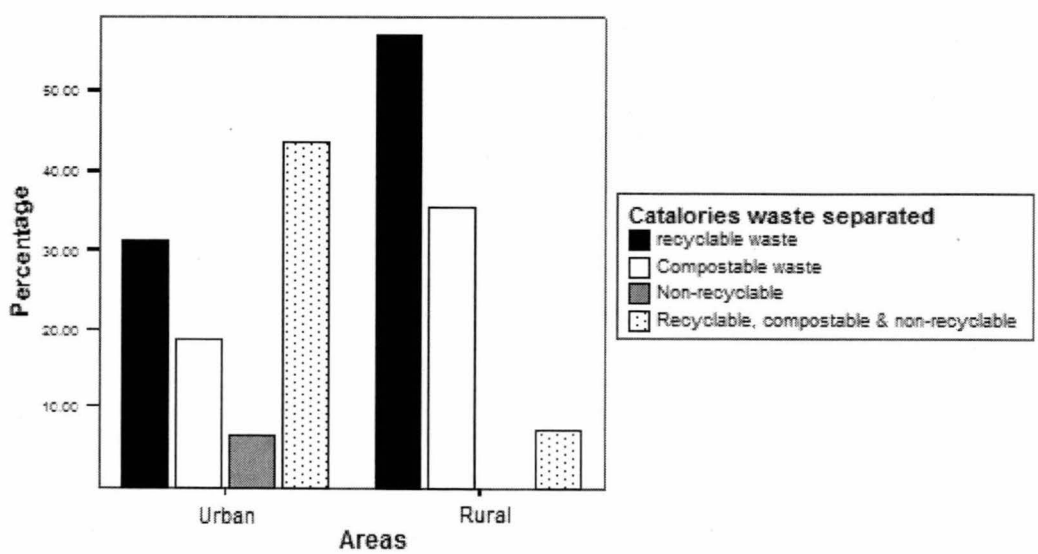


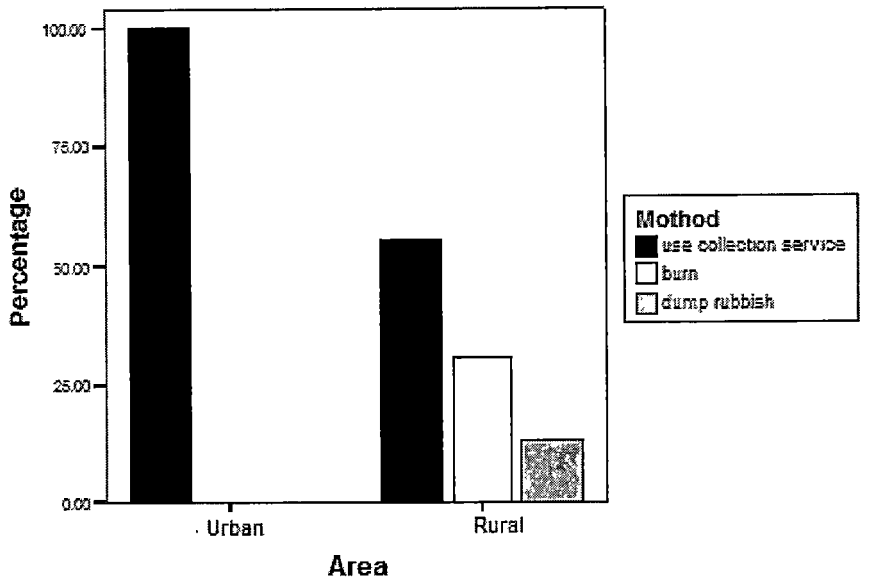
Figure 5.10 illustrates waste separation into different categories. In rural areas, almost 60 per cent of residents separated recyclable waste, followed by compostable waste (35 per cent), and less than 10 per cent of houses separate all three sources of waste: recyclable, compostable, and non-recyclable waste. In contrast, about 40 per cent of urban residents separate all categories of waste, 31 per cent of households separate recyclable waste only, around 18 per cent separate compostable waste followed by 6 per cent of households which separate non-recyclable only.

Figure 5.10: Different categories of waste separated by area



As indicated in figure 5.11, the majority of residents in urban areas disposed of their waste through waste collection services, and approximately 50 per cent of respondents in rural areas. However, 30 per cent and 13 per cent of residents in rural areas usually dispose of their waste by burning and open dumping of waste respectively.

Figure 5.11: Usual method of waste disposal by area



5.3.2.3 The possibility of improving waste disposal

In the rural areas, 60 per cent of respondents are aware of the potential negative effects of open waste-dumping (Table 5.4), while 40 per cent of respondents in urban areas are also aware of the negative effects. However, the opposite trend is observed in rural areas, with 40 per cent of them unaware of the effects. A similar trend is observed in terms of awareness towards the negative effects of burning waste with the majority of urban households (75 per cent) not aware of the effects of burning waste, while the majority of rural dwellers (60 per cent) are aware of the negative effects of burning waste.

Table 5.4 Aware of dumpling and burning waste by area

	Aware of effects of dumping waste		Aware of effects of burning waste	
	Urban	**Rural**	**Urban**	**Rural**
Yes	40%	60%	25%	60%
No	59%	40%	75%	35%

Respondents who are aware of the effects of open-dumping and burning rubbish indicated that health problems and environmental pollution are their main concern. This is followed by their concern towards the odour and cleanliness of their areas. In addition, a number of residents in rural areas indicated that while they are aware of the negative impacts of burning waste, they still have to keep burning their waste since the waste collection services do not cover their area.

Urban residents are more willing to separate their waste as opposed to rural residents. The survey data (table 5.4) illustrates that respondents in urban areas (70 per cent) are willing to separate their recyclable waste, followed by compostable waste (60 per cent), and non-recyclable waste (52 per cent). Around 42 per cent of rural residents answered that they would be prepared to separate the recyclables, 48 per cent of their compostable waste, and about 67 per cent of residents are not prepared to separate non-recyclable waste.

Table 5.5: Willingness to separate waste by area

	Recyclable		Compostable		Non-recyclable	
	Urban	**Rural**	**Urban**	**Rural**	**Urban**	**Rural**
No	30.0%	42.3%	40.0%	48.1%	48.0%	67.3%
Yes	70.0%	57.7%	60.0%	51.9%	52.0%%	32.7%

5.3.2.4 The possibility of improving waste disposal and collection services

About half of the respondents in urban and rural areas do not consider that their waste collection service has improved in the last five years (figure 5.12). Around 10 per cent of respondents said that the collection service is worse. The majority of residents in rural areas think that their waste collection service has improved since they started using it and only a small percentage think that it is worse.

Figure 5.12: Collection service improvement in the last five years by area

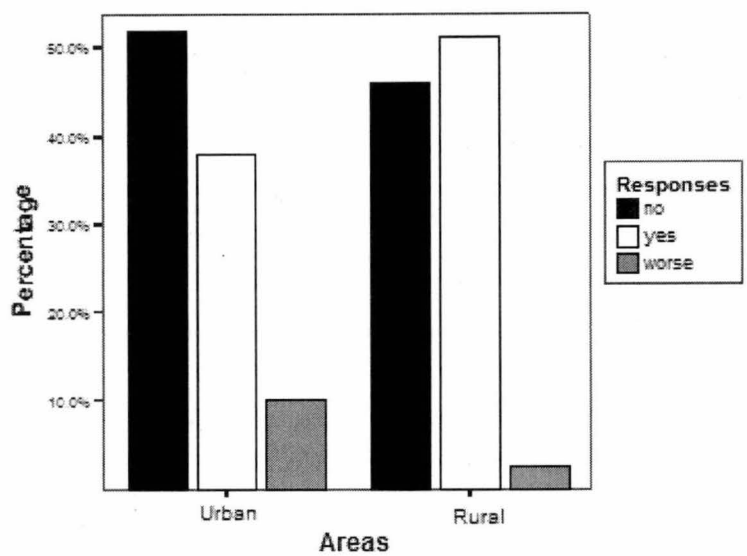
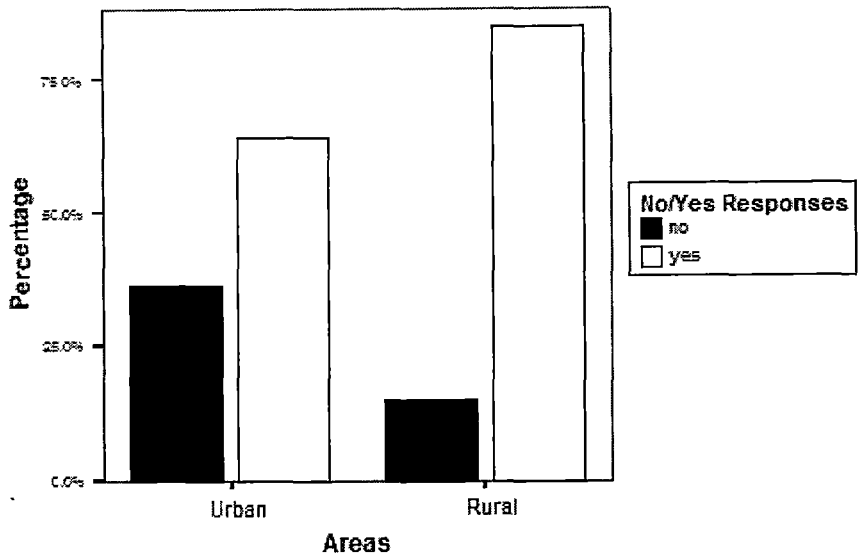


Figure 5.15 shows more than 50 per cent of respondents in both urban and rural areas are satisfied with their waste collection service. The highest percentage (85 per cent) of customer satisfaction can be found in rural areas. Around 36 per cent of residents in urban and 15 per cent in rural areas are not satisfied with the waste collection service. The reasons for their dissatisfaction are outlined below:

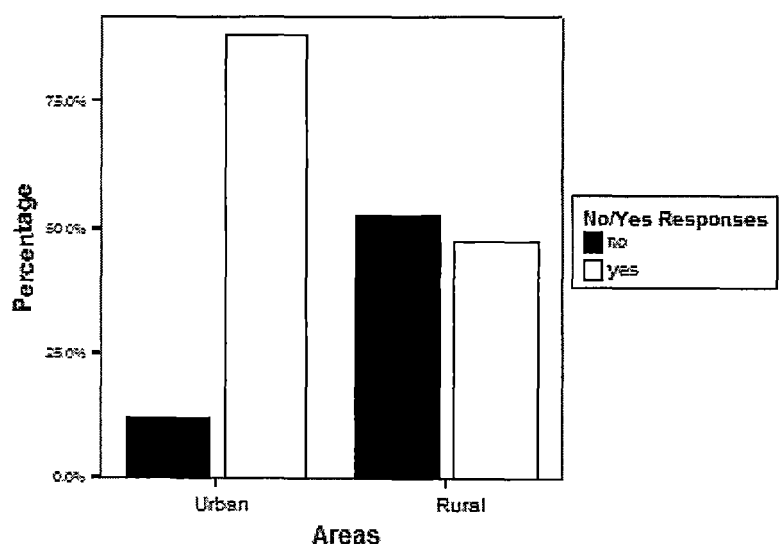
- waste collector personnel often handle the rubbish bin unprofessionally, for instance, throwing the rubbish bins, and leaving waste remnants on the ground.
- the waste collection service does not occur on time or regularly.
- an extra fee is charged for any additional services.

Figure 5.13: Satisfaction with waste collection service by area



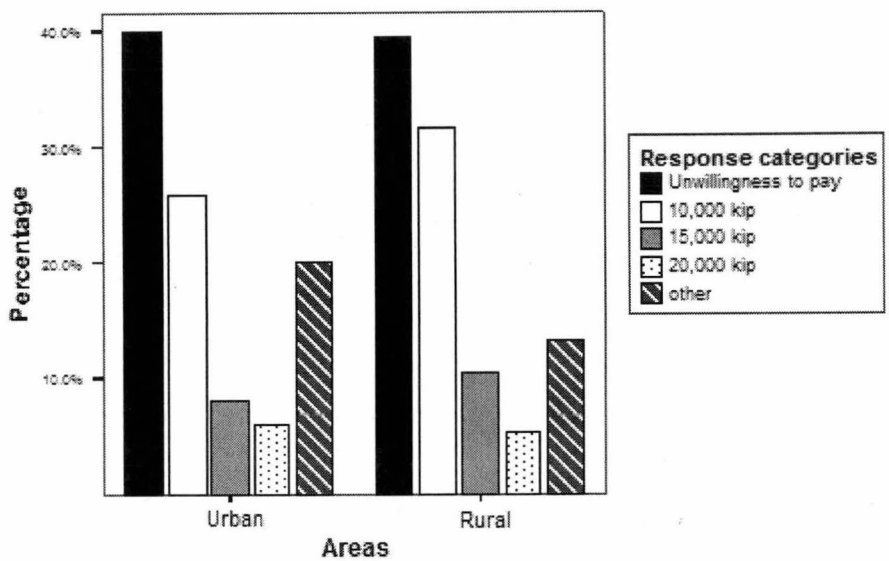
More than 80 per cent of residents in urban areas can afford their current waste collection service (figure 5.14). In contrast, approximately 52 per cent of residents in rural areas said that they cannot afford the waste collection service. The reasons for this are that the collection fee is expensive, and the service should base charges on the quantities of waste disposal.

Figure 5.14: Capacity of afford waste collection service by area



The majority of residents in both areas are not willing to pay in order to improve the waste collection service (figure 5.15). However, between 25 per cent and 30 per cent of all residents are willing to pay 10,000 kip (AUS $1) to improve their current waste collection service. 10-20 per cent of householders are willing to pay 5000 kip (AUS $ 0.50) or less for improved service, and less than 10 per cent of residents are willing to pay between 15,000 – 20,000 kip (AUS $ 1.50 - $2).

Figure 5.15: Willingness to pay for improved service by area



The majority of the respondents indicated more bins and plastic bags should be provided by the service providers, as the main priority. This is followed by the professionalism and appropriate behaviours of waste collectors (such as not throwing the bins around), and collecting waste regularly.

5.4 Discussion

Strengths and weaknesses of SWM development vary in different countries. However, it is believed that lack of financial sources, weak technical capacity, lack of awareness among residents and insufficient government policies and institutional arrangements are the most important factors that are hindering the management of solid waste in Lao PDR.

5.4.1 Waste collection service

The findings of this study indicate that waste collection services are still poorly managed in Lao PDR, with only 60 per cent of urban households receiving a weekly waste collection service, while about 35 per cent of rural households receive a weekly waste collection service. Similarly, in line with ESL's (2004a) findings, the research indicates that many households in the rural area have no waste collection service. Specifically, in this study, 40 per cent of households in rural areas indicated that their area is not covered by any waste collection service at all. As a result, the majority of rural residents engaged in inappropriate handling of solid waste such as illegal dumping and open burning (ESL, 2004b; Khanal & Soksavath, 2005). Indeed, the findings of this study show that 30 per cent and 13 per cent of rural respondents burn their waste and illegally dump their waste in open areas.

Open burning of waste is a major concern in Lao. Not only does smoke from open burning contribute to localised as well as city-wide pollution, it is also detrimental to the health of residents through the inhalation of respirable suspended particulates, including carbon monoxide, nitrogen dioxide and sulphur dioxide (Boadi & Kuitunen, 2005). Indeed, 25 per cent of urban households and 55 per cent of rural households in this research indicated that they are aware of the potential negative impacts of open burning, but have little choice because of the inadequate waste collection services.

Apart from the inadequacy or absence of waste collection services in some areas, residents that use waste collection services generally perceive the services are of low quality and standards. Indeed, the findings of this research indicate that 36 per cent and of the residents in urban and 15 per cent in rural areas are not satisfied with their waste collection service providers. Three main reasons given for the dissatisfaction are the unprofessional conduct of waste collectors, such as throwing the rubbish bins and leaving waste remnants on the ground, the waste collection service does not occur in a timely and regular fashion and there are no standard bins and standard fees for waste collection services, where extra fees are often charged for any additional services. Indeed, in an interview with VUDAA personnel, they indicated that they do not provide bins for most of the households, and an extra fee is often charged for additional services such as carrying extra loads of household waste.

Supporting the above data provided by VUDAA, this thesis findings indicate that 88 per cent of the households in urban and 90 per cent in rural areas, are not provided with bins by their waste collection services providers. However, the findings of this research are contrary to the findings observed in developed countries such as Australia. For instance, Chayabutra (1994) found a very low dissatisfaction rate among Hobart residents relating to their waste collection services. In addition, in his study, Chayabutra (1994) indicated that the main reason for householders' dissatisfaction was the fact that one bin per household was not enough to accommodate all their waste.

The findings of this research also partially support the notion that the major concerns relating to the public's poor perception of SWM in third world countries such as Lao PDR, are weak technical capacity, and insufficient government legislation in guiding SWM (Boadi & Kuitunen, 2005; ESL, 2004a; STEA & UNEP, 2006). Flowing on from that, SWM and practices in third world countries are believed to improve at a slower rate compared to developed countries due to lack of financial support (Boadi & Kuitunen, 2005; ESL, 2004a). The above notion is also supported by the current research, where approximately 50 per cent of the respondents both in urban and rural areas do not believe that their waste collection services have improved over the last five years. This clearly shows the lack of technical capacity (such as, trained staff, knowledge and expertise) in solid waste management in Lao. In addition, the slow improvement rate in Vientiane could also be potentially explained by the unwillingness of the majority (approximately 40 per cent of respondents) of both urban and rural households to pay for service improvement. Although the majority of the respondents were unwilling to pay for improved service, some of the respondents indicated that they was willing to pay extra if the waste collection is improved. However, none of them were willing to pay beyond the price range of AUS $ 1.50 to AUS $ 2.00 per month. A more detailed survey is required in the future to fully comprehend SWM.

It should be noted that the VUDAA waste collection fee for normal household waste is more expensive than the other two private contractors. The findings indicate that the VUDAA monthly charge is around 24,000 kip or AUS $ 2.40, while the other two private waste companies charge only 18,000 kip or AUS $

1.80 per month per household. In addition, an over the limit waste fee is charged by VUDAA and the two private contractors. Specifically, VUDAA charges an additional 6,000 kip or AUD $ 0.60 per bamboo bin, while the other two private contractors charge an additional 4,000 kip or AUS 0.40 per bamboo bin.

5.4.2 Waste disposal

According to ESL (2004a) and STEA and UNEP (2006), the main problems countered by the Lao government in terms of disposing waste at landfill are that there is no clear segregation between waste (it is a mixture of organic, household, and in some cases, hazardous waste) prior to being disposed at landfill; there is insufficient technological capacity in managing landfill such as no compaction of waste (open dumping); and the problems for waste pickers of being exposed to disease and toxins.

Indeed, the above problems associated with disposed waste at Lao landfill were also encountered in this research. For instance, approximately 40 per cent of urban households indicated that they never separate their waste into household waste and recyclable waste categories, whilst 67 per cent of rural dwellers indicated that they never separate their waste. This could indicate that urban dwellers are more aware of the importance of waste separation compared to rural dwellers. Similarly, this could also be due to the fact that urban dwellers have easier access to SWM facilities such as recycling centres, landfills or skip bins as opposed to rural dwellers. Having said that, the high percentage of both urban and rural dwellers that do not separate their waste is a major concern, because numerous studies have indicated that this mixture is not only contaminating underlying aquifers, it also contributes to the flooding in landfill area in the monsoon rainy season (ESL, 2004a). This will indirectly impact on residents' health and the increased likelihood of disease. To cite an example, a study in Jakarta found a correlation between unseparated garbage at landfill and the occurrence of infectious diseases caused by rodents and flies (Surjadi, 1993).

From interviews with the two private contractors, they indicated that their major concerns are related to the open dumping and irregular coverage of waste at landfills. Apparently, this poor management of landfill has many detrimental effects from environmental impacts to household health issues. Furthermore, they also indicated that this could be attributed to the lack of financial support by the government, lack of technical expertise in landfill management and lack of appropriate equipment and technologies such as leachate control technologies.

In addition, the two private contractors indicated that they are worried about the presence of waste pickers for two reasons. Firstly, they are concerned about the safety of the waste pickers as heavy machinery and vehicles are constantly present at the landfill. Secondly, they are concerned about the health of waste pickers as they are more likely to be exposed to a variety of health related problems. Indeed, ESL (2004a) found that some of the waste pickers were infected with hand and mouth diseases, and cases of food poisoning have been established among waste pickers.

Chapter 6: Conclusion and Recommendations

6.1 Conclusion

This study demonstrates the problems associated with SWM in Lao PDR. By interviewing three key players directly associated with solid waste management in Lao PDR, valuable information and insights were obtained. Firstly, many of the households in Vientiane Municipality in both urban and rural areas, are still not covered by waste collection services. This is especially true for rural dwellers, which in turn leaves them no choice other than burning their waste and/or openly and yet illegally dumping their waste in open areas. Several extant studies have shown various environmental and health impacts associated with open burning and illegal dumping of waste. Also, the findings of this research indicate that households have low awareness with regard to the proper technique of separating waste sources, and the importance of waste separation. From the perspective of SWM providers, the findings of this study indicate that SWM practices are not carried out in an efficient way, from the collection of waste itself to the management of landfill. This is mainly due to the lack of financial capacity, technical expertise and knowledge, the lack of appropriate technology (as can be seen by the usage of open dump-trucks and bamboo bins). This also results in the slow improvement rate of solid waste management in Lao PDR. Therefore, it is no surprise that the public have poor perceptions with regard to the management of solid waste in Lao PDR. In essence, SWM in Lao PDR is not sustainable at this point.

6.2 Recommendations

The recommendations that can be drawn from this research are as follows:

1. ***Establish a sound strategy, policy or legislative framework in which a reliable collection system and regular service can be provided.*** As mentioned earlier in chapter 4, in terms of solid waste management, Lao PDR has a weak legislative framework that has failed to establish proper roles for the organisations involved in SWM. Therefore, sound and strong legislation needs to be established in order to cover waste management practices such as waste collection and the management of landfill. In addition, there are a number of lessons that can be learnt from developed countries such as Australia. Especially, Australian waste management policy frameworks place a greater emphasis on the producers of waste sources and they are required to take responsibility for waste treatment and disposal.

2. ***Increase community awareness regarding the importance of waste separation and proper waste disposal techniques.*** The open burning and dumping are alarming trends in Lao PDR. Governments should take initiatives so that these trends are minimised if not prevented. The establishment of recycling centres at public institutions is a positive and healthy step to achieve this overall goal. Strong coordination and cooperation among various stakeholders involved in waste collection should be emphasised, in order to ensure that the majority of households in both urban and rural are supplied with waste collection services. This will certainly reduce the incidence of open dumping and burning. Media channels could also be encouraged to convey the information to households with regards to the importance of proper SWM techniques in households. For example, waste awareness and educational programs should be made widely available via various types of media such as television, radio, magazines, and newspapers. More importantly, programs should be offered in schools and training centres and at a village level so that this will educate the new generation with regard to the importance of proper waste management in order to reduce harmful environmental effects.

3. ***Reinforcement of the management and administration system.*** The findings of this thesis indicate that Lao PDR still has weak SWM and technical capacities. As such, proper and adequate training should be provided to staff and there needs to be an ongoing organisational commitment to these training programs. Formal and on the job training needs to be more structured, particularly for workers and management personnel. Indeed, in Australia, the Australian Government Productivity Commission states that the Australian Government has to make refine information, education and awareness programs in both waste management issues and policies. In addition, investment in the appropriate technologies (such as closed-compact trucks) and waste management techniques such as leachate monitoring at landfill should be encouraged and promoted by the government. A lesson on landfill management could also be learnt from Australia's practices on landfill management. The most widely used management techniques used in Australia are compacting and covering the waste with soil regularly. In addition, extra measures such as lining, capping, and leachate recirculation are all parts of the waste management practices in Australia. In contrast, because Lao PDR's landfills mainly consist of open dumping, the focus should be shifted to adoption of the landfill management practices used in Australia.

4. ***Strengthening financial capacity.*** As mentioned in chapter 4, currently, the Lao government is partly sponsored by various nations and/or organisations/ non-government organisations, especially, the UNDP and JICA in regards to managing solid waste. This financial support needs not only to be maintained, it also needs to be boosted in order to continue support for SWM in Vientiane as well as in the whole country. For this reason, the government should continuously seek and secure funds from developed nations and/or organisations.

5. ***Establishment of a standard payment system for waste services.*** As indicated by the findings of this study, different organisations involved in solid waste management charge differently. There needs to be a standard and consistent payment system that applies to all households. However, the proven pay systems that are applicable in Australia need to be considered with caution before being applied in Lao PDR. The reason being that the strength of household income in both nations is clearly different, with the former ranked as one of the richest

countries in the world whilst the latter is the opposite. Ind eed, the payment system applicable in the Laos context provides an opportunity for future research in order to ensure that households are willing to pay in order for their waste to be disposed appropriately and what is an appropriate fee scale.

References

Ackerman, 2005: Cost-effective recycling. In C. Rasmussen & D. Vigso (Eds.), *Rethinking the waste hierarchy:* 1-21. Copenhagen: Environmental Assessment Institute for Miljovurdering.

Agency for Toxic Substances and Disease Registry (ATSDR), 2001: Landfill gas control measures. Available on-line at: <http://www.atsdr.cdc.gov/HAC/landfill/PDFs/Landfill_2001_ch5.pdf>, (accessed 25th September. 2008)

Angelelli, E. & Sperenza, M. G. 2002: The application of a vehicle routing model to a waste-collection problem: Two case studies. *Journal of the Operational Research Society*, 53 (9): 944-952.

Asian Development Bank (ADB), 2003: Solid waste management and income generation for Vientiane's poor project. Available on-line at: <http://www.adb.org/Documents/JFPRs/lao/jfpr-lao-37651.pdf>, (accessed 15th March. 2008)

Asian Development Bank (ADB), 2004: Lao PDR: Water Resources Coordinating Committee, Available on-line at: <www.adb.org/water/nwsab/2004/Lao_PDR_country_paper.pdf>, (accessed 25th June. 2008)

Asian Development Bank (ADB), 2006: Country Synthesis Report on Urban Air Quality Management, Lao PDR. Available on-line at: <http://www.adb.org/Documents/Reports/Urban-Air-Quality-Management/lao%20pdr.pdf>, (accessed 24th June. 2008)

Asian Development Bank (ADB), 2008: Lao People's Democratic Republic: Vientiane Urban Infrastructure and Services Project. Available on-line at: <http://www.adb.org/Documents/PCRs/LAO/33432-LAO-PCR.pdf>, (accessed 18th June. 2008)

Association of Municipal Engineers, 1991: *Recycling household waste: The way ahead.* West Sussex: Faygate Printing Services.

Australian Bureau of Statistics, 1998: Waste Management Industry: Australia, 1996-1997. Available on-line at: <http://www.abs.gov.au/ausstats/abs@.nsf/mediareleasesbyReleaseDate/4015D0F0342E5B46CA2568A9001362D9?OpenDocument>, (accessed 27th August. 2008)

Australian Bureau of Statistics, 2003: *Environmental issues: People's views and practices*. Available on-line at: <http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/B91A18D868909E31CA256DE9007443C1/$File/46020_mar%202003.pdf>, (accessed 27th August. 2008)

Australian Government Productivity Commission, 2006: *Waste management*. Victoria.

Ayotamuno, J. M. & Gobo, A. E. 2004: Municipal solid waste management in Port Harcourt, Nigeria: Obstacles and prospects. *Management of Environmental Quality*, 15 (1): 389-400.

Baccini, P., Henseler, G., Figi, R. & Belevi, H. 1987: Water and element balances of municipal solid waste landfills. *Waste Management & Research*, 5 (1): 483-389.

Becklake, S. 1991: *Waste Disposal and Recycling*. Aladdin Books Ltd: London

Beede, D, N. & Bloom, D. E. 1995: The economics of municipal solid waste. *The World Bank Research Observer*, 10 (2): 113-151.

Beede, D. N. & Bloom, D. E. 1996: Coping with municipal solid waste in developing countries. In S. Yusuf, W. Wu & S. Evenett (Eds.), *Local dynamic in an era of globalization*: 175-184. Washington: The World Bank.

Beranek, W. 1992: Solid waste management and economic development. *Economic Development Review*, 10 (3): 49-52.

Bernstein, J. D. 1991: Alternative approaches to pollution control and waste management: Regulatory and economic instruments. The World Bank Organisation. Available on-line at: <http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/1991/04/01/000009265_3961001125114/Rendered/PDF/multi_page.pdf>, (accessed 6th June. 2008)

Boadi, O. K. & Kuitunen, M. 2005: Environmental and health impacts of household solid waste handling and disposal practices in third world cities: case study of the Accra Metropolitan area, Ghana. *Environmental Health*, 68 (4): 32-36.

Bose, A. & Blore, I. 1993: Public waste and private property: An enquiry into the economics of solid waste in Calcutta. *Public Administration and Development*, 13 (1): 1-15.

Brown, V., Orr, L. & Smith, D. 1992: *Acting locally: Meeting the environmental information needs of local government*. Canberra: Centre for Resource and Environmental Studies.

Bruner, P. H. & Feliner, J. 2007: Setting priorities for waste management strategies in developing countries. *Waste Management & Research*, 25 (3): 234.

Bruner, P. H. 1996: Editorial. *Waste Management & Research*, 14: 1-2.

Bureau of Industry Economics, 1993: *Waste Management and landfill pricing*. Canberra: Australian Government Publishing Service.

Cameron, D. 2008: Towards emissions trading. *Engineers Australia*, 80 (1): 25-32.

Central Intelligence Agency (CIA), 2008: The world fact book: Laos. Available on-line at: <https://www.cia.gov/library/publications/the-world-factbook/geos/la.html>, (accessed 24th June. 2008)

Chayabutra, C. 1994: *The roles of government, the private sector, and residents in solid waste management: Lessons from a case study in greater Hobart local government areas, Tasmania*. Unpublished doctoral thesis, University of Tasmania, Hobart.

Chinitz, B. 1990: Growth management: Good for the town, bad for the nation? *Journal of American Planning Association*, 56 (1): 3-9.

Christchurch City Council, 2006: Toward Zero Waste. Available on-line at: <http://www.ccc.govt.nz/Waste/managementplan/WasteManagementPlan2006.pdf>, (accessed 9th May. 2008)

Christensen, T. H. 1989: Environmental aspects of sanitary landfilling. In R. Cossu. & R. Stegmann (Eds.), *Sanitary landfilling: Process technology and environmental impact*: 19-25. London: Academic Press.

Commonwealth Environment Protection Agency, 1992: *National waste minimisation and recycling strategy*. Canberra: Senate Printing Unit.

Commonwealth of Australia, 1994: *Waste disposal: A report from the senate standing committee on environment, recreation and the arts*. Canberra: Senate Printing Unit.

Cutts, L. & Osborn, D. 1989: *Diversity in local government systems: The Australian local governments handbook*. Canberra: Australian Government Publishing Service.

Department of Environment, Queensland, 1996: Waste Management Strategy for Queensland. Available on-line at: <http//www.epa.qld.gov.au_publicationsp00572 aa.pdf> (accessed 6th May. 2008)

Department of Primary Industries, Water, and Environment. 2004: Landfill sustainable guide. Available on-line at: <http://www.environment.tas.gov.au/ downloads/Landfill_Sustainability_Guide%202004.pdf>, (accessed 5th May. 2008).

Department of the Environment and Heritage, 2005: *Waste sector greenhouse gas emissions projections*. Available on-line at: <http://www.greenhouse.gov.au/ projections/pubs/ waste2005.pdf>, (accessed 29th August. 2008)

Domfeh, K. A. 1999: Some environmental factors affecting health in the Greater Accra Metropolitan Area, Ghana. *Environments*, 27 (2): 1-13.

Earth Systems Lao (ESL), 2004a: *JICA follow-up survey on assistance for waste management.* Unpublished paper prepared for Japan International Cooperation Agency (JICA).

Earth Systems Lao (ESL), 2004b: *Integrated Solid Waste Management in Vientiane Municipality 2003-2004: External Mid-Term Review.* Unpublished paper prepared for United Nation Development Program.

Encyclopedia of the Nations, 2008: National economies encyclopedia Asia and the Pacific: Lao PDR. Available on-line at: <http://www.nationsencyclopedia.com/economies/Asia-and-the-Pacific/>, (accessed 23rd September. 2008)

Environment Australia, 1991: *Waste minimisation manual for local government: A guide to resources, issues and best practice*. Victoria: Environment Australia.

Environment Protection Agency SA, 1998: *EPA guidelines: Major solid waste landfill depots*. Available on-line at: <http://www.epa.sa.gov.au/pdfs/swlandfill.pdf>, (accessed 29th August. 2008)

Environment Protection Authority (EPA) NSW, 1996: Environmental guidelines: Solid waste landfills. Available on-line at: <http://www.epa.nsw.gov.au/resources/solidlandfill.pdf >, (accessed 23 April. 2008)

Environment Protection Authority (EPA) Victoria, 2008: Waste. Available on-line at: <http://www.epa.vic.gov.au/waste/default.asp>, (accessed 2nd July. 2008)

Ferrara, I. 1999: *Essays on solid waste management: The impact of user fees*. Unpublished doctoral thesis, York University, Canada.

Fullerton, D. & Kinnaman, T. 1996: Household responses to pricing garbage by the bag. *American Economic Review*, 86 (4): 971-984.

Furedy, C. 1993: Working with the waste pickers: Asian approaches to urban solid waste management. *Waterloo*: 19 (2): 18

Gandy, M. 1993: A critical analysis of environmental policy in developed economies: The case of recycling. *Institutions and the Environment*, 1: 1.

Harrison Market Research, 2005: *Working with the community: Report for zero waste SA*. Adelaide: Government of South Australia.

Hobson, A. M. B. 2007: *Methane and nitrous oxide from waste composting*. Unpublished doctoral thesis, Open University, United Kingdon.

Houtven, G. V. & Morris, G. 1999: Household behaviour under alternative pay-as-you-throw systems for solid waste disposal. *Land Economics*, 75 (4): 515-537.

Hubick, K. T. 1991: *Management & technologies of wastes: A perspective- Australia 1990*. ACT: CPN Publications.

Intergovernmental Panel on Climate Change, 2006: Waste generation, composition, and management data. Available on-line at: <http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/V5_2_Ch2_Waste_Data.pdf>, (accessed 12th August. 2008)

Japan International Cooperation Agency (JICA), 1999: Country profile on environment: Laos. Available on-line at: <http://www.jica.go.jp/english/global/env/profiles/e99lao.pdf>, (accessed 12th September. 2008)

Jones, G. W, 1999: Population of South East Asia. Available on-line at: <http://dspace-dev.anu.edu.au/bitstream/1030.58/12298/2/81.pdf>, (accessed 12th September. 2008)

Keen, M. & Mercer, D. 1993: Environmental planning at the local level: The example of local conservation strategies in Victoria, Australia. *The Environmentalist*, 13 (2): 83-95.

Kelleher, M. & Dixie, J. 2000: User pay in Canada. *Solid waste & Recycling*, 5 (3): 8-11.

Khanal, B. R & Souksavath, B. 2005: Environmental Management measures and current practices in solid waste management: A case study from Vientiane, Lao People's Democratic Republic. *Journal of GMS development studies*, 2 (1): 79 – 99

Khotsay, K. & Vilaythong, D. 2005: Regional training workshop on the inventory of hazardous waste generation: Country report. Available on-line at: <http://www.basel.int/stratplan/oewg1/projdocs/indonesia/rpt-laos.doc>, (accessed 8th September.2008)

KPMG Lao Company Limited, 2008: Investment in Lao PDR. Available on-line at: <http://www.kpmg.co.th/Publications/tax_legal/InvestmentinLao2008.pdf>, (accessed 24th August, 2008)

Kristensen, J. 2001: *Food Security & Development in the Lower Mekong River Basin: a challenge for the Mekong River Commission.* Paper delivered at the Asia and Pacific Forum on Poverty, Manila.

Lah, T. J. 2001: *Municipal solid waste management: A case study of Indianapolis.* Unpublished doctoral thesis, Indiana University, Indiana.

Lindhqvist, T. 2000: Extended producer responsibility in cleaner production: Policy principle to promote environmental improvements of product systems. Available on-line at: <http://www.lub.lu.se/luft/diss/tec355.pdf>, (accessed 29th August. 2008)

Linowes, R. & Hupert, M. B. 2006: The tropical waste dilemma: Waste management in Panama. *International Journal of Emerging Markets*, 1 (3): 225-234.

Litter and Recycling Research Association, 1993: *Garbage bin analysis and recycling audit.* Available on-line at: <https://www.epa.nsw.gov.au/soe/95/192.htm>, (accessed 27th August. 2008)

MacDonald. M. A. 2004: Proposed methodology for siting of compost facilities in Vientiane, Lao PDR. Available online at: <http://www.utoronto.ca/waste-econ/MacDonaldthesis%20final%20report%20take%202.pdf>, (accessed 10th June. 2008)

Madina, M. 2005: Co-operatives benefit waste recyclers. *Appropriate Technology*: 32 (3): 53.

Miranda, M. L., Miller, J. M. & Jacobs, T. L. 2000: Talking trash about landfills: Using quantitative scoring schemes in landfill siting processes. *Journal of Policy Analysis and Management*, 19 (1): 3-22.

Morage-Gonzalez, J. L. & Padron-Fumero, N. 2002: Environmental policy in a green market. *Environmental and Resource Economics*, 22 (3): 419-449.

Morris, G. E. & Holthausen, D. M. 1994: The economics of household solid waste generation and disposal. *Journal of Environmental Economics and Management*, 26 (3): 215-235.

Musson, S. E., Jang, Y. C., Townsend, T. G. & Chung, I. H. 2000: Characterisation of lead leachability from cathode ray tubes using the toxicity characteristics leaching procedure. *Environment Science Technology*, 34: 4376.

Nathanson, J. A. 1986: *Basic environmental technology: Water supply, waste disposal, and pollution control.* New Jersey: Prentice Hall.

National Centre for Environmental Economics (NCEE), 2001: The United States Experience with Economic Incentives for Protecting the Environment. Available on-line at: <http://usinfo.state.gov/infousa/economy/technology/docs/EE-0216B-13.pdf>, (accessed 20th August. 2008)

National Statistics Centre (NSC), 1995: *The population and housing census 1995.* Vientiane: State printing.

National Statistics Centre (NSC), 2005: *The population and housing census 2005.* Vientiane: State printing.

National Statistics Centre (NSC), 2006: *Statistical year book 2006.* Vientiane: State printing.

Nicholson, J. 2005: Australian to the CORE: The art of selling recycled organics. *Solid Waste & Recycling.* 10 (3): 34-35.

O'Gallagher, B. 1990: *Waste management technologies: Opportunities for research and manufacturing in Australia.* Sydney: Department of Industry, Technology and Commerce.

Organisation for Economic Co-operation and Development (OECD), 1983: *Household waste: Separate collection and recycling.* Paris Cedex, France: OECD Publications Office.

Phillips, P. S., Adams, K. T., Read, A. D. & Green, A. E. 2000: Regional variations in waste minimization in England: Challenges and issues for policy development. *Regional Studies*, 34 (3): 297-305.

Phillips, P. S., Clarkson, P., Adams, J., Read, A. D. & Coggins, P. C. 2003: County waste minimization programmes: A case study from Northamptonshire, UK. *Sustainable Development*, 11 (2): 103-119.

Phouxay, K. 2007: Internal migration and socio-economic change in Lao PDR. Available on-line at: <www.grm.cuhk.edu.hk/en/4ipgc/download/AroomLT1PPT/6A1Phouxay kab6A12July.ppt>, (accessed 24th August, 2008)

Pollock-Shea, C. 1988: Recycling urban wastes: Solving the garbage glut. *Academic Research Library*, 117 (2518): 88-92.

Price, J. L. & Joseph, J. B. 2000: Demand management- A basis for waste policy: A critical review of the applicability of the waste hierarchy in terms of achieving sustainable waste management. *Sustainable Development*, 8 (2): 96-105.

Qian, W. & Burritt, R. 2007: Environmental accounting for waste management: A study of local governments in Australia. *Environmentalist*, 27: 143-154.

Ramboll, 2007: Waste management. Available on-line at: <httm://viewer.zmags.com/getMagPdf. php?mid=wdqsd/>, (accessed 5th July. 2008)

Read, A. D. & Phillips, P. S. 1998: Waste minimization as a local government issue: Fact or fiction? *Sustainable Development*, 6: 78-91.

Regional data exchange systems, 2008: Profile of Lao People's Democratic Republic (LaoPDR). Available on-line at: <http://www.faorap-apcas.org/lao.html>, (accessed 24th June. 2008)

Rogers, H. 2005: *Gone tomorrow: The hidden life of garbage*. The New Press: London.

Russell, S. H. 1982: *Resource Recovery Economics: Methods for Feasibility Analysis*. New York: Marcel Dekker Inc.

Science Technology and Environmental Agency (STEA) & United Nations Environmental Program (UNEP), 2006: LAO P.D.R. National Environmental Performance Assessment (EPA) Report. Available on-line at:

<http://www.rrcap.unep.org/ sef/doc_pub/Laos%20EPA%20Report.pdf>, (accessed 18th September. 2008)

Science, Technology and Environmental Agency (STEA) & World Bank, 2005: Lao PDR Environment Monitor. Available on-line at: <http://siteresources.worldbank.org/NEWS/Resources/report-en.pdf>, (accessed 28th. August. 2008).

Scott, J., Beydoun, D., Amal, R., Low, G. & Cattle, J. 2005: Landfill management, leachate generation, and leach testing of solid wastes in Australia and overseas. *Critical Reviews in Environmental Science and Technology*, 35 (3): 239-333.

Siklossy, M. 1993: Management of solid wastes in Budapest. *Academic Research Library*, 60: 358-359.

Surjadi, C. 1993: Respiratory diseases of mothers and children and environmental factors among households in Jakarta. *Environment and Urbanization*, 5 (2): 78-86.

Tanthachoon. N, Chiemchaisri. C, Chiemchaisri. W, Tudsri. S, & Kumar. S. 2008: Methane Oxidation in Compost-Based Landfill Cover with Vegetation during Wet and Dry Conditions in the Tropics. *Pittsburgh:* 58(5): 603

Toowoomba Regional Council, 2008: Landfill – the end of the line for waste. Available on-line at: <http://www.toowoomba.qld.gov.au/index.php?option=com_docman&task=doc_view&gid=519&Itemid=71>, (accessed 18 August. 2008)

United Nations Development Program (UNDP), 2008: On the ground in Lao PDR. Available on-line at: <http://www.undplao.org/>, (accessed 24th June. 2008)

United Nations Environmental Programme (UNEP). 2001: Lao PDR - State of the environment. Available on-line at: <http://rrcap.unep.org/pub/soe/lao_urban.pdf>, (accessed 10th June. 2008)

Urban Cleansing Service Centre (UCSC), 1999: *Rules for Waste Disposal and Environmental Protection.* Vientiane: UCSC and Environmental Agency.

Urban Development Sector Unit, 1999: What a waste: Solid waste management in Asia. Available on-line at: <http://www.worldbank.org/urban/solid_wm/erm/CWG%20folder/uwp1.pdf>, (accessed 20 June. 2008)

Moorst, V. 1996: Toxic landfills: Some preliminary research findings, Report for Werribee Residents against toxic dumps (WRATD). Available on-line at: <http://www.21century.com.au/environment/wratd/Report1.html>, (accessed 29th June. 2008)

Waite, R. 1995: *Household waste recycling*. London: Earthscan.

Waste Econ, 2008: About waste-econ in Laos. Available on-line at: <http://www.utoronto.ca/waste-econ/abo-lao.html>, (accessed 18th September. 2008)

WEPA, 2008: Governmental activities – Lao PDR. Available on-line at: <http://www.wepa-db.net/ngos/government/laos/top.htm>, (accessed 10th June. 2008)

Wong. R.G, 2004: Analysis of separation options for composting market waste in Vientiane, Lao PDR. Available on-line at: <http://www.utoronto.ca/waste-econ/GenWong.pdf>, (accessed 23rd June 2008)

World Health Organisation (WHO), 2005: Lao People's Democratic Republic - Environmental Health Country Profile. Available on-line at: <http://www.environment-health.asia/fileupload/laopdr_ehcp_19May05.pdf>, (accessed 20th August. 2008)

Worthington, A. C. & Dollery, B. E. 2001: Measuring efficiency in local government: An analysis of New South Wales municipalities' domestic waste management function. *Policy Studies Journal*, 29 (2): 232-249.

Yousif, D. & Scott, S. 2007: Governing solid waste management in Mazatenango, Guatemala: Problems and prospects. *International Development Planning Review*, 29 (4): 433-451.

Zbinden, M. & Goodman, T. 2007: Commingled organics at yard trimmings composting site. *BioCycle*, 48 (9): 23-27.

Zia, H. & Devadas, V. 2007: Municipal solid waste management in Kanpur, India: Obstacles and prospects. *Management of Environmental Quality*, 18 (1): 89-108.

Vientiane Urban Development Administrative Agency
Survey Questionnaire

Interview date:...../...../2008

Your position:_____

Vientiane Municipality

Please tick the appropriate box or write in the appropriate spaces as required. You may tick more then one for some questions below. Thank you for your time.

Part 1: General details	
1. Which activities in solid waste management are you engaged in?	☐ Waste collection ☐ Waste disposal ☐ Operating and managing landfill ☐Other (specify) _____ _____ _____
2. How many private contractors are involved in providing waste management? Please list their name	_____ _____ _____ _____ _____
3. How many tonnes of waste are generated per annum by each source?	*Households:* 1995_____ 2000_____ 2005_____ 2007_____ *Commercial and institutional:* 1995_____ 2000_____ 2005_____ 2007_____

	Hospitals 1995_____ 2000_____ 2005_____ 2007_____ *Construction:* 1995_____ 2000_____ 2005_____ 2007_____ *Other (specify)*_____ 1995_____ 2000_____ 2005_____ 2007_____
Part 2: Collection services	
4. How many full time staff are employed in the waste collection service?	_____
5. How many vehicles does your company use for waste collection?	Hi-tech vehicles: _____ Open dump vehicles: _____
6. What types of waste management services do you provide?	☐ Collection ☐ Kerbside (recycle) ☐ Disposal ☐ Other (specify)_____
7. What kind of waste collection services does your company provide?	☐ Domestic household waste ☐ Commercial and institutional waste ☐ Hospital waste ☐ Construction waste ☐ Other (Specify)_____

8. Which districts in Vientiane Municipality does your waste collection service cover?

District	Yes	No	Please give details why you cannot cover all areas?
Chanthabury	☐	☐	_____
Sikhottabong	☐	☐	_____
Saisetha	☐	☐	_____
Sisattanak	☐	☐	_____
Naxaithong	☐	☐	_____
Xaithany	☐	☐	_____
Hatsaifong	☐	☐	_____

9. How many households/ commercial/ government institutional customers are using your service?	Households_____ Private sectors_____ Government institutions_____
10. Does your company provide bins or skips to commercial companics or institutions?	☐ Yes (specify)_____ ☐ No
11. Do you provide rubbish bins to householders?	☐ Yes (specify how many households) _____ ☐ No (specify who provide) _____

12. How often do you collect the waste?

	Weekly	Fortnightly	More than once a week
Households	☐	☐	☐
Commercial & institutional	☐	☐	☐
Hospitals	☐	☐	☐
Construction	☐	☐	☐
Other (Specify) _____	☐	☐	☐

13. In which district and for how many households (HH) does your service collect waste?	Monday (District)_____ (No. of HH)_____ Tuesday (District) _____ (No. of HH)_____ Wednesday (District)_____ (No. of HH)_____ Thursday (District)_____ (No. of HH)_____ Friday (District)_____ (No. of HH)_____ Saturday (District)_____ (No. of HH)_____ Sunday(District)_____ (No. of HH)_____
14. How many tonnes of waste were collected per day per year on average?	1995_____ 2000_____ 2005_____ 2007_____
15. How many tonnes of waste collected and disposed at the km36 landfill per annum?	1995_____ 2000_____ 2005_____ 2007_____
16. What are the working hours of your collection service? eg. 8am-12pm	☐ Household_____ ☐ Commercial_____ ☐ Institutional_____ ☐ Other_____
17. What is the monthly charge for your waste collection service?	☐ Households_____ ☐ Industries_____ ☐ Hospitals_____

	☐ Construction sites_____ ☐ Other (specify)_____

18. How are important considerations in providing your waste collection service?

	Not Important	Important	Very important
Adequate transport	☐	☐	☐
Adequate staff	☐	☐	☐
Appropriate landfill	☐	☐	☐
Vehicle maintenance	☐	☐	☐
Running costs	☐	☐	☐
Other _____	☐	☐	☐

Part 3: Waste disposal

19. Where do you dispose of the following categories of waste?

	Km 36 landfill	Other (specify)
▪ Household waste	☐	☐ _____
▪ Industrial & construction waste	☐	☐ _____
▪ Hospital waste	☐	☐ _____

20. What are the current environmental effects of solid waste disposal in Vientiane Municipality?	_____ _____ _____ _____

Part 4: Landfill site

21. How many h.a is the landfill site?	_____
22. Who are the financial supporters for operating the km36 landfill?	_____ _____

23. Please describe the risk management methods used to prevent environmental risks

- leachate pollution _____
- stormwater flooding _____

- production of methane gas _____
- Odor _____
- Other (specify) _____

24. Are these considerations important in the effective operation of Km36 landfill?	Yes / No Adequate staff ☐ ☐ Appropriate landfill ☐ ☐ Weak financial status ☐ ☐ Running costs ☐ ☐ ☐Other _____
Part 3: The possibility of improving waste disposal and collection services	
25. What are the future plans to improve solid waste management?	_____ _____ _____
26. Is there any way you could improve the waste collection service?	_____ _____ _____ _____
27. What can you do to improve your waste disposal site?	_____ _____ _____ _____ _____
28. Please suggest how could the amount of waste disposed at Km 36 landfill be reduced?	_____ _____ _____ _____

Private Waste Contractors Survey Questionnaire

Interview date:...../...../2008

Your position in the company:_____

Vientiane Municipality

Please tick the appropriate box or write in the appropriate spaces as required. You may tick more then one for some questions below. Thank you for your time.

Part 1: General details of the contractor	
1. Does your company sub-contract for the government?	☐ Yes ☐ No
2. How many staff does your company employ for the waste collection service?	_____
3. How many vehicles does your company have for waste collection?	☐ Hi-tech vehicles: _____ ☐ Open dump vehicles: _____ ☐ Other _____
Part 2: Collection service	
4. What types of waste management service does your company provide?	☐ Collection ☐ Kerbside (recycle) ☐ Disposal ☐ Other (specify)_____
5. What kind of waste collection services does your company provide?	☐ Domestic household waste ☐ Commercial and institutional waste ☐ Hospital waste ☐ Construction waste ☐ Other (Specify)_____

6. Does your company provide rubbish bins to householders?	☐ Yes. What kind of bin? ☐ Recycle bin ☐ General waste bin ☐ No
7. Does your company provide bins or skips to commercial companies or institutions?	☐ Yes (specify)_____ ☐ No
8. How many tonnes of waste material did your company collect?	2003 _____ 2004 _____ 2005 _____ 2006 _____ 2007 _____
9. Please estimate the volume of each following category: ▪ Industrial & construction material _____ ▪ Office waste _____ ▪ Electronic waste_____ ▪ Hospital waste _____	
10. In which district and for how many households (HH) does your service collect waste?	Monday (District)_____ (No. of HH)_____ Tuesday (District) _____ (No. of HH)_____ Wednesday (District)_____ (No. of HH)_____ Thursday (District)_____ (No. of HH)_____ Friday (District)_____ (No. of HH)_____ Saturday (District)_____ (No. of HH)_____ Sunday(District)_____ (No. of HH)_____

11. How many households/ commercial customers are using your service?	☐ Households _____ ☐ Commercial _____
12. What are the working hours of your collection service? eg. 8am-12pm	☐ Household_____ ☐ Commercial_____ ☐ Institutional (e.g hospital, school, ect.) _____ ☐ Other_____
13. What is the monthly charge for your waste collection service?	☐ Households_____ ☐ Industries_____ ☐ Hospitals_____ ☐ Construction sites_____ ☐ Other (specify)_____

14. What are important considerations in providing your waste collection service?

	Not Important	Important	Very important
Adequate transport	☐	☐	☐
Adequate staff	☐	☐	☐
Appropriate landfill	☐	☐	☐
Vehicle maintenance	☐	☐	☐
Running costs	☐	☐	☐
Other _____	☐	☐	☐

15. Can you suggest how your company could improve its waste collection services?	_____ _____ _____ _____ _____ _____

Part 3: Waste disposal

16. Where do you dispose of the following categories of waste?

	Km 36 landfill	Other (specify)
▪ Household waste	☐	☐ _____
▪ Industrial & construction waste	☐	☐ _____
▪ Hospital waste	☐	☐ _____

17. Please list any concerns you have about waste disposal at the Km 36 landfill	_____ _____ _____ _____ _____ _____
18. Please suggest how could the amount of waste disposed at Km 36 landfill be reduced	_____ _____ _____ _____ _____ _____ _____

Households Survey Questionnaire

Interview date:...../...../2008

Village:.....

District:.....

Vientiane Municipality

Please tick the appropriate box or write in the appropriate spaces as required. You may tick more then one for some questions below. Thank you for your time.

Part 1: Waste collection service	
1. How often does the waste collection service occur at your household?	☐ No service ☐ Once every week ☐ Once every fortnight ☐ More than once a week
2. a. Does the waste collection service provide you with rubbish bins? Yes ☐ No ☐ b. If so, how many bins does it provide?	☐ One ☐ Two ☐ More than two
3. When does the waste collection service usually occur?	☐ Morning ☐ Afternoon ☐ Evening
4. Which collection services do you use for your normal waste?	☐ Urban cleansing service ☐ Private contractor ☐ No idea ☐ No service
5. a. Has your waste collection service ever failed to pick up the rubbish? ☐ Yes ☐ No ☐ No idea b. If so, how often?	☐ Once a week ☐ Once a month ☐ Once in three/six months ☐ Once a year ☐ Other (specify) _____

Part 2: Waste disposal	
6. a. Do you separate waste into different categories in your household? ☐ Yes ☐ Sometimes ☐ Never b. If so, how do you separate it?	☐ Separate recyclable waste (bottles, plastic bags, cans, cardboard, etc.) ☐ Separate composting waste (organic matter – eg: fruit, and vegetable scraps, etc. or green waste – plant material) ☐ Separate non-recyclable waste (paper, sanitation items, plastic bags, etc.) ☐ Other (specify) _____
7. How do you usually dispose of your waste?	☐ Use the collection service ☐ Burn ☐ Dump rubbish ☐ Other (specify) _____
Part 3: The possibility of improving waste disposal	
8. Are you aware of the effects on other people of: ▪ Dumping rubbish ☐ Yes ☐ No ▪ Burning rubbish ☐ Yes ☐ No If yes, please name some of those effects _____ _____ _____	
9. Would you be prepared to separate your waste into ▪ Recyclable waste ☐ Yes ☐ No ▪ Compostible waste ☐ Yes ☐ No ▪ Non-recyclable waste ☐ Yes ☐ No	
Part 4: The possibility of improving waste disposal and collection services	
10. Do you think the waste collection service has improved in the last five years?	☐ Yes ☐ No ☐ Worse

11. Are you satisfied with your waste collection service?	☐ Yes ☐ No (specify why): _____
12. Can you afford waste collection services?	☐ Yes ☐ No

13. In order to improve waste collection and disposal services, would you be willing to pay more?

☐ Yes, how much more would you be willing to pay

- ☐ 10.000 kip *
- ☐ 15.000 kip
- ☐ 20.000 kip
- ☐ Other _____

☐ No (specify why) _____

14. Can you suggest some ways to improve your waste collection and disposal services?	_____

* AUS $ 1is around 10.000 kip